# WATER CONTROL MANUAL

# FOR

# DWORSHAK DAM AND RESERVOIR

# NORTH FORK

# CLEARWATER RIVER, IDAHO


**U.S. ARMY CORPS OF ENGINEERS**

**WALLA WALLA DISTRICT**

**NOVEMBER 1986**

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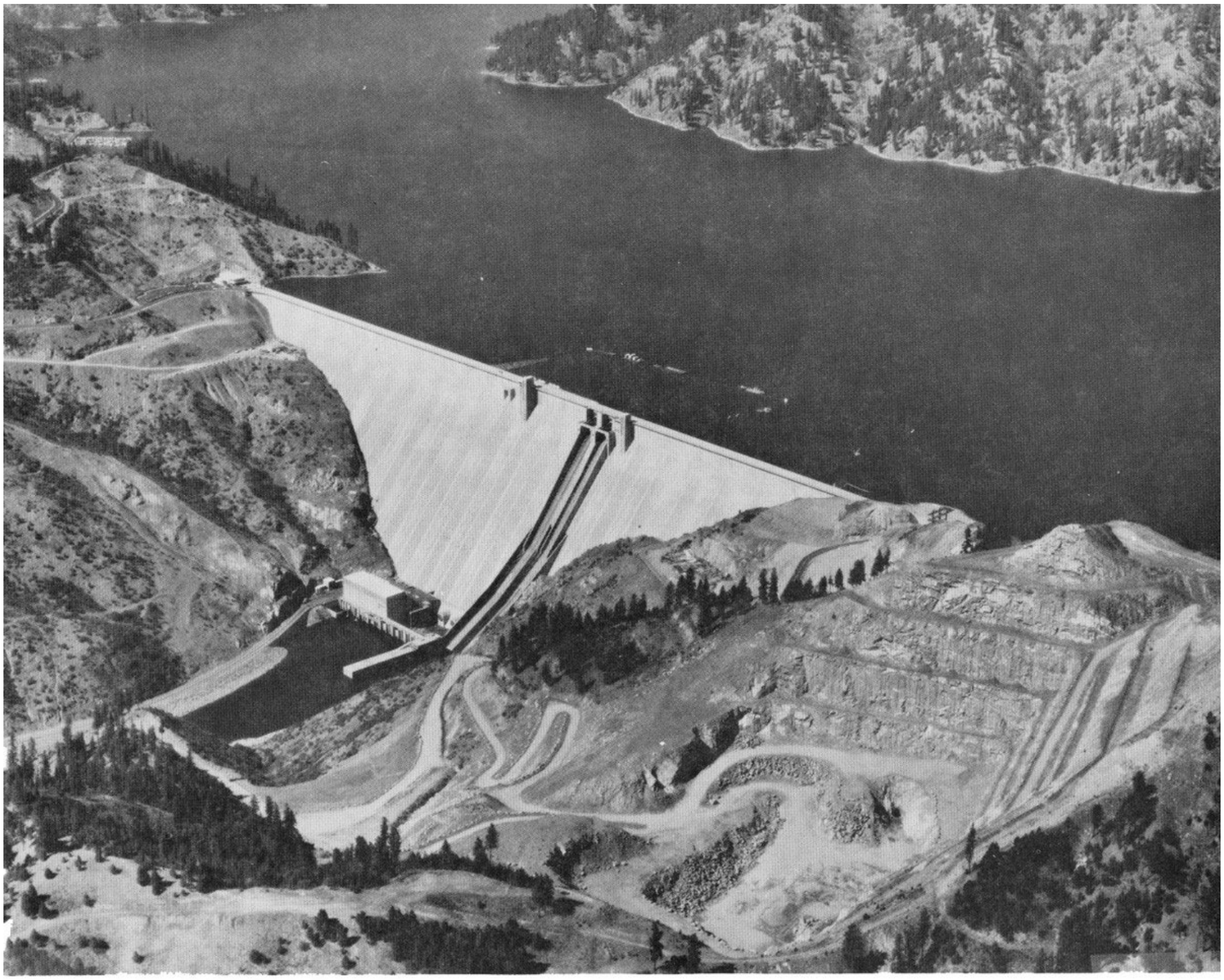

DWORSHAK DAM AND RESERVOIR

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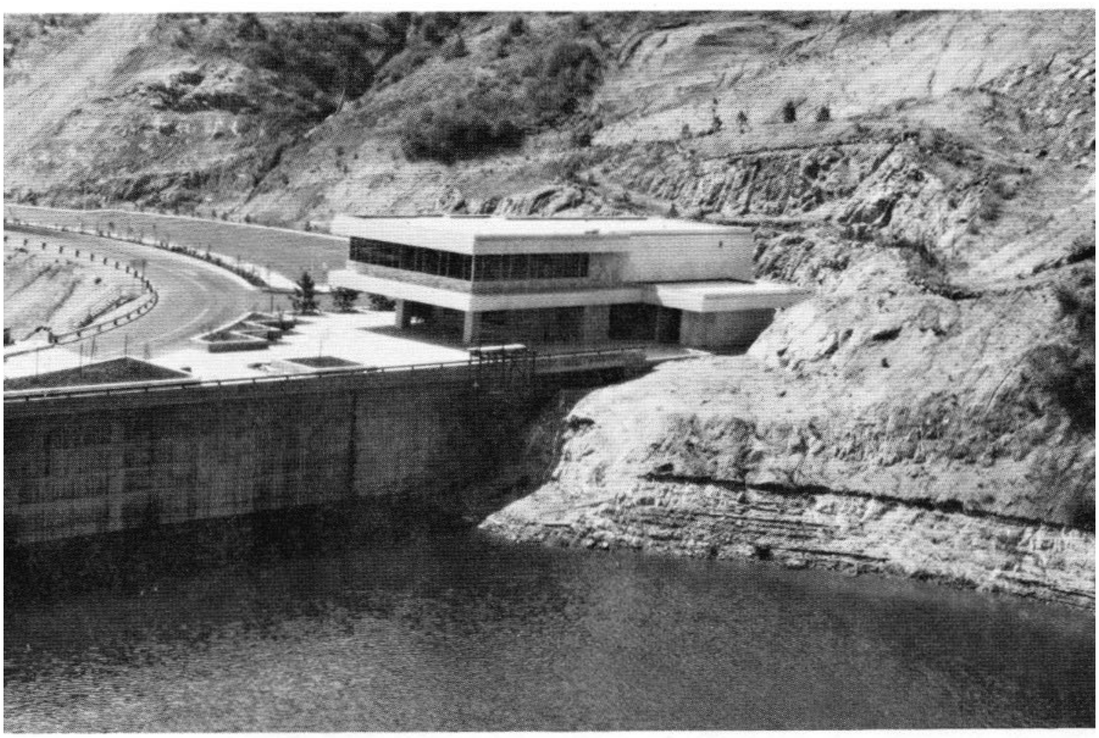

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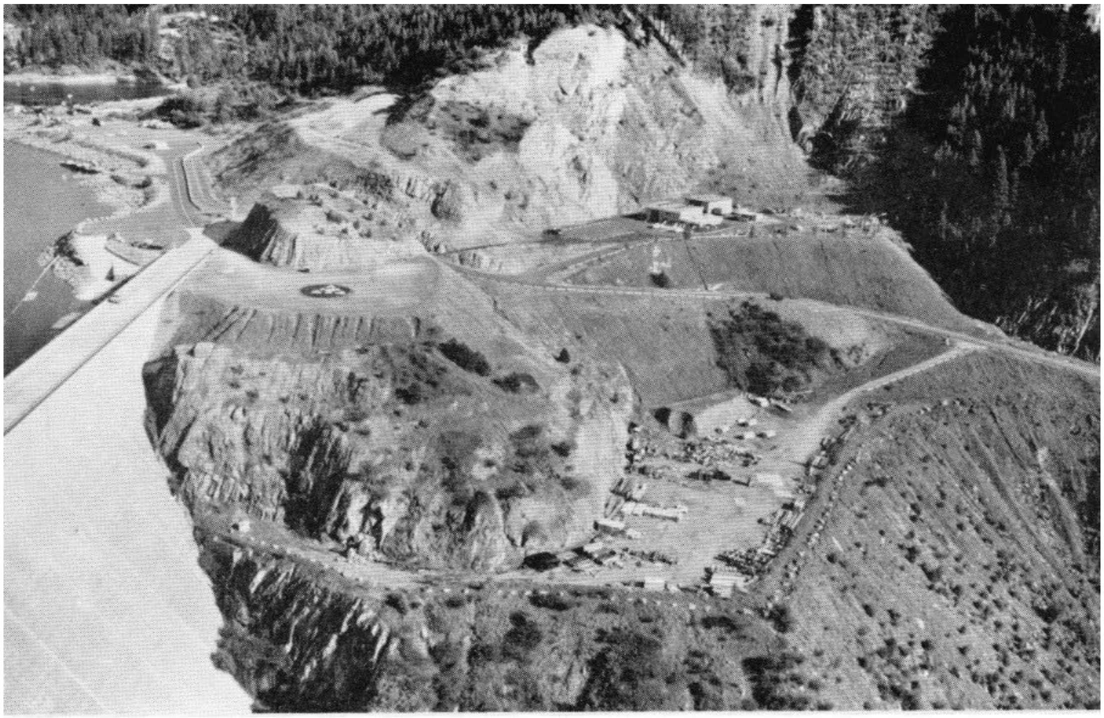

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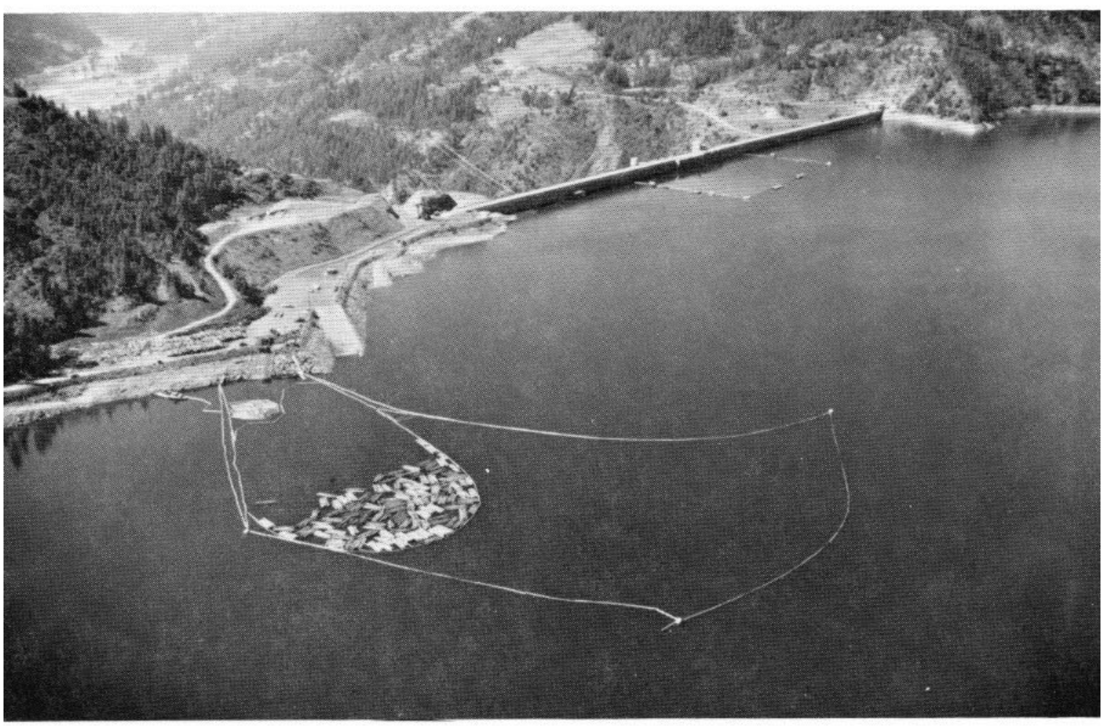

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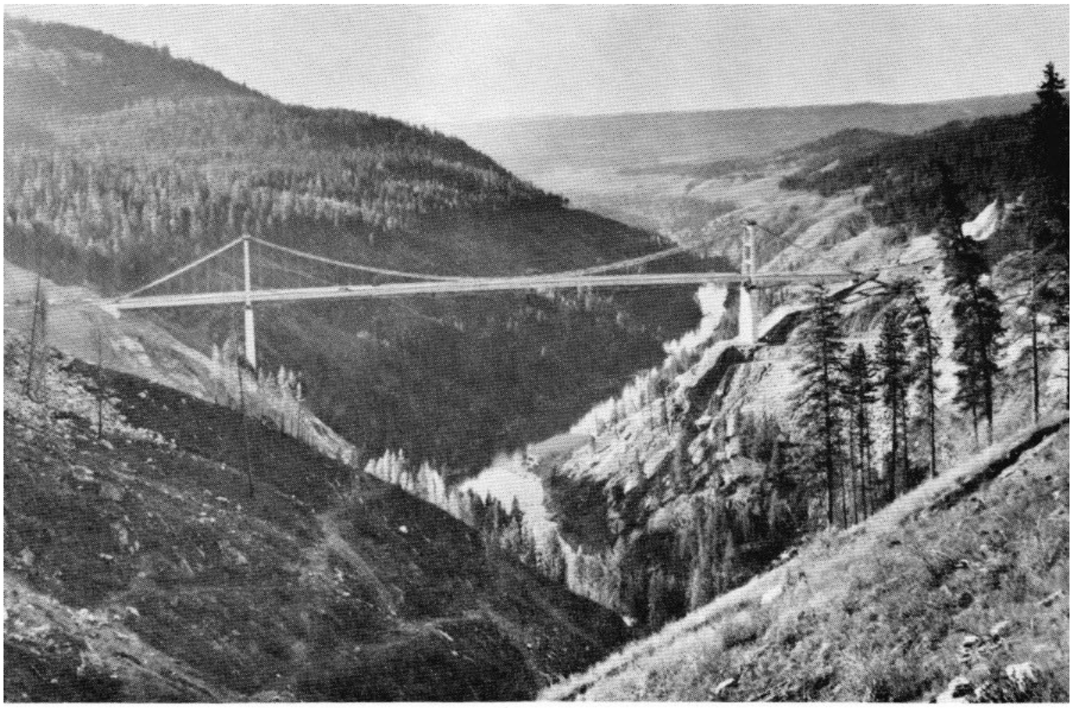
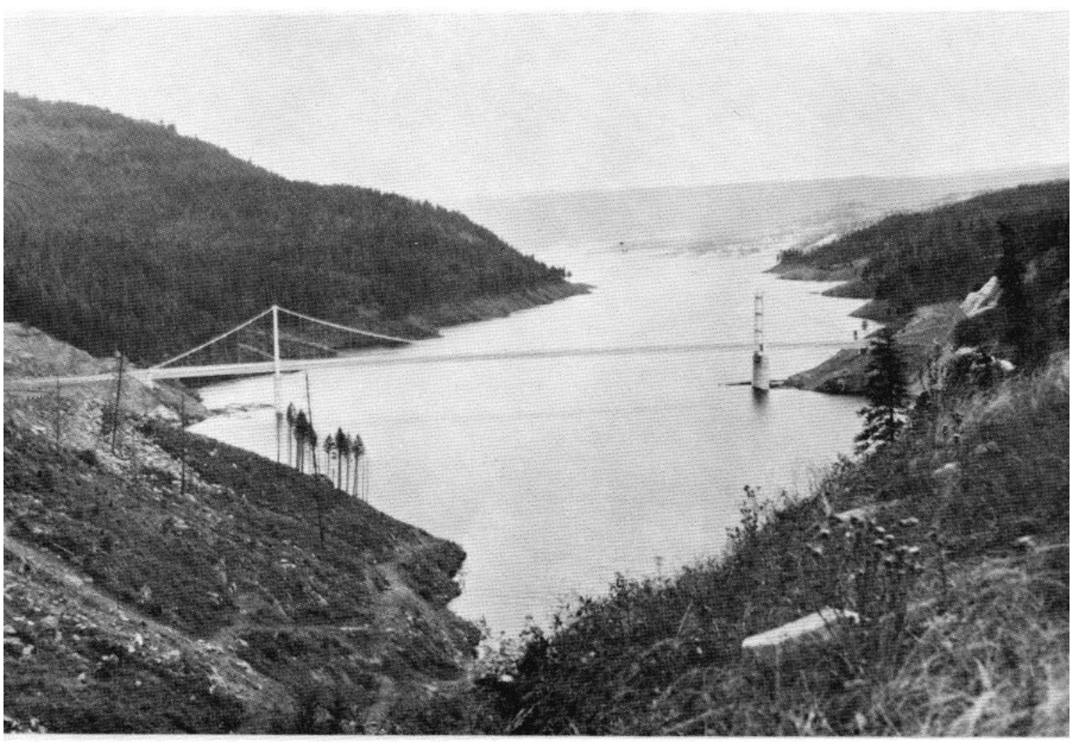


Dent Bridge – Before Pool Filling



Dent Bridge – After Pool Filling

## NOTICE TO USERS OF THIS MANUAL

Regulations specify that this Water Control Manual be published in loose leaf form, and only those sections, or parts thereof, requiring changes will be revised and printed. Therefore, this copy should be preserved in good condition so that inserts can be 2made to keep the manual current.

As a continuing program it will be necessary to revise portions of this manual annually in order to keep it up to date. Revisions to this manual will be made by the Walla Walla District's Planning Division (Hydrology Branch). Pertinent discharge rating tables must be revised when changes become evident in the stage-discharge relation; likewise, changes in the plan of operation will be made for the purpose of improving regulation technique, and project developments may occur which require revision of the information presented in the manual. Whenever revisions are necessary, new pages containing the revised material will be printed with the date of revision and issued to each person having a copy of the manual to that substitution may be made.

(3) Flooding and damage caused by earthquakes, sabotage, cracking equipment malfunction, leakage, and foundation failures.

Catastrophic floods should be coordinated according to existing criteria within the Flood Emergency Subplans – Dworshak Dam, North Fork Clearwater River, Idaho, U.S. Army Engineer District, Walla Walla August 1982.

Equipment failures that would prevent the controlled discharge of water passing through the project powerhouse or spillway would be an emergency and should be coordinated according to criteria within Operation and Maintenance (O&M) Manual - Dworshak Dam - North Fork Clearwater River, Idaho, U.S. Army Engineer District, Walla Walla, December 1977.

Project function emergencies affecting power generation are the responsibility of the Dworshak Project Engineer or his representative. If an emergency occurs or appears to be developing, the Project Engineer will contact the Walla Walla District, Chief, OCR Division, for instructions. If the nature of the emergency is such as to require immediate action, the Project Engineer may take necessary action and report to Chief, OCR Division as soon as possible. The Bonneville Power Administration (BPA) dispatcher will be notified of any emergency which may affect power production.

National type emergencies should be coordinated according to Annex K, Appendix 3, of the Walla Walla District Continuity of Operations Plan, which describes actions to be taken at Dworshak project under various types of national emergencies (terrorist attack, sabotage, nuclear war, etc.). The project can be used as a public fallout shelter during a nuclear attack situation.

# PERTINENT DATA

Corps of Engineers
North Pacific Division, Portland, Oregon

## GENERAL

| | |
|---|---|
| River Mile | 1.9 |
| Drainage area, square miles | 2,440 |
| Effective hydraulic height, feet | 632 |
| Maximum structural height, feet | 717 |
| Overall length at crest, feet | 3,237 |
| Stream flow, cfs: | |
| Minimum of record | 250 |
| Mean annual | 5,727 |
| Maximum of record | 100,000 |
| Stream flow, acre-feet: | |
| Minimum annual | 2,157,000 |
| Mean annual | 4,100,000 |
| Maximum of record | 6,680,000 |
| Standard project flood peaks, cfs: | |
| Winter | 160,000 |
| Spring | 120,000 |
| Probable design discharges, cfs: | |
| At pool elevation 1445 | 32,290 |
| At pool elevation 1600 | |
| Spillway | 150,000 |
| Outlets | 40,000 |
| Total at elevation 1600 | 190,000 |
| Total at surcharge pool elevation 1604.7 | 220,000 |
| Tailwater elevations: | |
| Minimum, discharge 1,000 cfs | 968 |
| Maximum, at discharge 150,000 cfs | 1,003.4 |
| First power-on-line | 1 March 1973 |

ESTIMATED COST

| | |
|---|---|
| As of 1 July 1973 | $302,000,000 |

RESERVOIR

| | |
|---|---|
| Elevation, feet: | |
| Maximum design pool | 1,605 |
| Maximum operating pool | 1,600 |
| Normal operation range | 1,445-1,600 |
| Storage capacity, acre-feet: | |
| Gross | 3,468,000 |
| Usable, flood control and power | 2,016,000 |
| Length at elevation 1600, miles | 53.6 |
| Shoreline length, miles | 175 |
| Surface areas, acres: | |
| At elevation 1600 | 17,090 |
| At elevation 1445 | 9,050 |
| Recreation sites, number: | |
| Initial | 7 |
| Ultimate | 19 |

DAM

| | |
|---|---|
| Type | Concrete Gravity |
| Crest elevation | 1613 |
| Deck width, feet | 44 |
| Concrete volume, yards | 6,500,000 |
| Upstream slope | Vertical |
| Downstream slope | Vertical above elevation 1560, 1V on 0.8H below |
| Elevators, number | 3 |

SPILLWAY

| | |
|---|---|
| Type | Gate controlled, with stilling basin |
| Gates: | |
| Type | Tainter |
| Size, width by height, feet | 50 x 56.4 |
| Number | 2 |
| Crest elevation | 1545 |
| Crane, one, capacity, tons | 50 |

PERMANENT OUTLET

| | |
|---|---|
| Water passages: | |
| Number | 3 |
| Type | Conduit |
| Size, feet | 12 x 17 |
| Valves, type and number: | |
| Tainter | 3 |
| Tractor (emergency) | 1 |
| Intake centerline elevation | 1362 |

POWERPLANT

| | |
|---|---|
| Initial installation: | |
| Number of units | 3 |
| Nameplate rating, kilowatts: | |
| Two, each | 90,000 |
| One | 220,000 |
| Total | 400,000 |
| Ultimate installation: | |
| Number of units | 6 |
| Nameplate rating, kilowatts: | |
| Two, each | 90,000 |
| Four, each | 220,000 |
| Total | 1,060,000 |
| Powerhouse, length, feet | 428 |
| Turbine type | Francis |
| Turbine ratings, horsepower: | |
| Small units | 142,000 |
| Large units | 346,000 |
| Synchronous speed, revolutions per minute: | |
| Small units | 200 |
| Large units | 128.6 |
| Distributor centerline elevations: | |
| Small units | 969 |
| Large units | 975 |
| Spacing, feet: | |
| Small units | 47 |
| Large units | 65 |

| | |
|---|---|
| Penstock diameters: | |
| Small units | 12 |
| Large units | 19 |
| Penstock intake elevations, feet msl: | |
| Small units | 1,420.68 |
| Large units | 1,412.70 |
| Gross head, feet | 632 |
| Rated head, feet | 560 |
| Minimum head, feet | 477 |
| Crane: | |
| Number | 2 |
| Type | Bridge |
| Capacity, each, tons | 350 |

<u>RELOCATIONS</u>

| | |
|---|---|
| Roads, miles: | |
| Highway districts | 2.7 |
| County | 24.3 |
| Bridges, number | 2 |

<u>FISH HATCHERY, STEELHEAD</u>

| | |
|---|---|
| Attraction water pump capacity, cfs | 255 |
| Capacity, adult size | 6,000 |
| Yearly fingerling release: | |
| Estimated number | 3,360,000 |
| Estimated total weight, pounds | 420,000 |

# 1 INTRODUCTION

1-01 Authorization.

This Water Control Manual has been prepared according to authority contained in Section 7 of ER 1110-2-240, “Engineering and Design - Water Control Management,” dated 8 October 1982. The format and content of this manual are in accordance with criteria set forth in EM 1110-2-3600, dated 25 May 1959, and ETL 1110-2-251, “Engineering and Design - Preparation of Water Control Manuals,” dated 14 March 1980.

1-02 Purpose and Scope.

The purpose of this manual is to present information pertinent to the regulation of Dworshak Reservoir and to provide a reference source for higher authority and personnel responsible for the regulation of Dworshak for flood control, power production, recreation, and conservation uses. Criteria and information within this manual replace the contents of the “Preliminary Reservoir Regulation Manual” for Dworshak Dam and Reservoir, U.S. Army Engineer District, Walla Walla, October 1974. Items discussed within this manual are as follows:

a. History of project.

b. Description of project.

c. Basin characteristics.

d. Data collection and communication networks.

e. Water control management.

f. Hydrologic forecasts.

g. Water control plan.

h. Effect of water control plan.

1-03 Related Manuals and Reports.

A list of published design memoranda is provided in Exhibit 1-1 of this manual. The following list outlines manuals and reports which contain information and data pertinent to Dworshak Dam and Reservoir Water Control Manual.

a. Design Memorandum No. 1 - Hydrology, 15 December 1960.

b. General Design Memorandum (3 Volumes), 15 September 1961.

c. Preliminary Reservoir Regulation Manual - Dworshak Dam and Reservoir, Idaho; U.S. Army Engineer District, Walla Walla, October 1974.

d. Final Environmental Impact Statement - Dworshak Dam and Reservoir, Idaho; U.S. Army Engineer District, Walla Walla, September 1975.

e. Operation and Maintenance Manual - Dworshak Dam (3 Volumes); U.S. Army Engineer District, Walla Walla, December 1977.

f. Flood Emergency Subplans - Identification, Operation, Repair, Notification, and Inundation Maps - Dworshak Dam and Reservoir, Idaho; U.S. Army Engineer District, August 1982.

g. Hydraulic Model Investigation, Technical Report No. 116-1, Dworshak Dam - North Fork Clearwater River, Idaho, September 1984.

h. Columbia River Basin - Master Water Control Manual, December 1984.

i. Design Memorandum No. 26 - Dworshak Master Plan, Volume I, July 1985.

## 1-04 Project Owner and Operator.

The Federal Government owns the Dworshak Project. The Walla Walla District Corps of Engineers is responsible for the operation and maintenance of the Dworshak Project and its facilities.

## 1-05 Operating Agency.

See 1-04 Project Owner and Operator.

## 1-06 Regulating Agencies.

The regulation of Dworshak for maximum benefits related to flood control, power generation, and downstream fisheries requires close cooperation and coordination between the Corps of Engineers, Bonneville Power Administration, Fish and Game agencies, and others. The North Pacific Division Corps of Engineers is responsible for the daily water regulation of Dworshak. The Bonneville Power Administration is authorized to market electrical energy generated from Dworshak and other Federal agencies. Section 9 - WATER CONTROL MANAGEMENT outlines organization responsibilities of the key agencies connected with the management of Dworshak and other Corps of Engineers, North Pacific Division, projects.

# 2 DESCRIPTION OF PROJECT

2-01 Location.

The following data outlines the location of Dworshak Dam. Plate 2-1 shows the geographical location of the project.

| | |
|---|---|
| **Stream:** | **North Fork of the Clearwater River** |
| River Mile: | 1.9 (North Fork) |
| Drainage Basin: | Clearwater River |
| Drainage Area: | 2,440 Square Miles |
| State: | Idaho |
| County: | Clearwater |

Location from nearby communities (approximate road mileage):

2 miles north Ahsahka
4 miles west of Orofino
40 miles east of Lewiston

2-02 Purpose.

Dworshak Dam is a multipurpose project which controls water from the 2,440-square-mile drainage area above the dam. The project is operated for flood control protection, power generation, recreation, water quality, and fish and wildlife uses. Refer to Section 7 - WATER CONTROL PLAN for project use priorities and regulation plans.

2-03 Physical Components.

The following paragraphs discuss in general terms the physical components of Dworshak Dam and Reservoir. The Dworshak Dam Operation and Maintenance Manual (3 volumes), December 1977, provides detail on the operation and maintenance of the project's physical components. A general plan of the dam is shown on Plate 2-2.1. Dam elevations for upstream and downstream views are shown on Plate 2-2.2. Plan and sections of the spillway and outlets are shown on Plate 2-2.3, and an isometric view of the galleries, penstocks, and outlets is shown on Plate 2-2.4.

a. Dam.

Dworshak Dam is a straight concrete-gravity structure which has a maximum structural height of 717 feet, a hydraulic height of 632 feet, and a crest length of 3,287 feet. The crest width is 44 feet and provides a 28-foot roadway, curb to curb. The width of the structure under the roadway is 30 feet, and the maximum base width is 574 feet. The back slope of the dam, starting at elevation 1,560 is 1V on .8H and slopes to the powerhouse deck at elevation 1,005. The structure contains approximately 6,500,000 cubic yards of concrete.

b. Spillway.

The spillway is located on the dam towards the left abutment, with the centerline on the construction base line. The spillway consists of a concrete chute extending down the back slope of the dam from ogee crest elevation 1,545 to the stilling basin floor at elevation 931. The spillway crest width is 122 feet, consisting of two 50-foot bays and one 22-foot center pier.

Discharge over the spillway is regulated by two 50-foot-wide x 56.4-foot-high tainter gates. Plate 2-3.1 shows the spillway gate elevation and arrangement. The tainter gate elements consist of the skin-plate assembly, horizontal girders, side frames, and trunnion anchorage. Low-alloy steel is used for the skin plate and ribs, and the balance of the gate is fabricated from steel. The two spillway gates are operated by individual hoists. Each drive-hoist unit is powered by a 10-Hp, 3-phase, 480-volt splashproof induction motor which is locally controlled at the hoists. Refer to Dworshak Dam Operation Manual, Volume 2, Part II - Operation and Maintenance, for details on operation of spillway gate machinery. The tops of the spillway gates in the closed position are at elevation 1,600.65. The design capacity of the two gates at full pool elevation 1,600 feet is 157,000 cfs at the full-open position (bottom of gates at 1,596). The combined spillway and outlet capacities at maximum design pool (1,605 feet) meet the requirement for passing the regulated probable maximum flood of 220,000 cfs. Outlet capacity at maximum design pool (1,605 feet) is 40,000 cfs. The spillway discharge ratings are shown in Table 2-1 and on Plate 2-3.2.

During freezing weather, the side seal plates and sill beams for the two spillway gates can be heated to protect the seals from ice damage. Heating is by electrically heated oil circulated through tubing embedded behind the seal plates and sill beams. Equipment and controls for heating gate seals are located in the 1,603.5 gallery directly above the spillway.

A spillway stilling basin is located directly below the spillway. The stilling basin is excavated in rock and is lined with reinforced concrete. The structure is 115.4 feet wide by 270 feet long. The concrete floor of the basin is at invert elevation 931, and the top of the end sill is at elevation 951. From the end sill downstream, the stilling basin is in rock that is cut on a slope of 1 foot vertical to 4 feet horizontal (1V on 4H). Stilling basin design capacity is 40,000 cfs. The regulated probable maximum flood is 220,000 cfs. Regulated releases into the stilling basin would be approximately 180,000 cfs from the spillway and 40,000 cfs from the three outlet conduits.

Tailwater curves, as determined by backwater and model studies, are shown on Plate 2-7 and Plate 2-8, respectively.

c. Outlet Works.

Three outlets are available for evacuation of reservoir storage below the spillway crest (elevation 1,545). The center outlet is located beneath the intermediate pier which separates the two spillway bays. The other two outlets are also located beneath the spillway, but these outlets flank the spillway gates. Discharge capacity of the three outlets varies from 23,100 cfs at minimum pool elevation 1,445 feet to 39,750 cfs at full pool elevation 1,600 feet. The outlets all seal at elevation 1,350 by hydraulically operated tainter valves. The tainter valves are 9 feet wide by 12.5 feet high. Plate 2-4.1 shows details of the tainter valve and gate slot arrangement for each of the outlet conduits. The discharge ratings of the valves are shown in Table 2-2 and graphically displayed on Plate 2-4.2.

(1). Aeration Deflectors.

In 1984, aeration deflectors were installed in the outlets to increase the amount of air entrained in the flow through the outlets. Air entrained flow will reduce the potential for cavitation damage along the walls and floor of the three outlet conduits.

(2). Emergency Gate.

Slots have been provided downstream from the intake bellmouth of each of the outlet conduits to accommodate a fixed wheel emergency gate. Only one emergency gate is provided which is lowered into the slots by use of a 50-ton gantry crane. Emergency gate slots can be used during spillway operation. Additional weight was added to the emergency gate in 1984 to insure closure capability of a regulating outlet during an emergency.

(3). Tainter Valves.

The tainter valves are an eccentric-trunnion type and are 9 feet wide by 12.5 feet high. The principal elements of a valve are the skin-plate assembly, vertical girders, struts, and trunnions. Modified low-alloy steel is used for the skin plate, and the balance of the gate is fabricated from steel. The valve struts are bolted to the trunnion arms with high-strength bolts for future removal of the valve, if necessary.

Valve operation consists of three phases: retraction, raising or lowering, and sealing. Rotation of the eccentric-trunnion shafts by a pivoted hydraulic cylinder and lever arm arrangement either advances or retracts the valve 3/4 inch. Each valve is raised or lowered by another pivot-mouthed hydraulic cylinder. Individual hydraulic systems are provided for each tainter valve and serve both the operating cylinder and the cylinder which operates the eccentric.

Approximate valve operating times, including retraction and sealing operations, are 2-¼ minutes for raising completely and 3 minutes for lowering from the full raised position. A complete set of operating controls, position sensing devices, and indicators are provided for each valve machinery room. Remote controls and indicators are provided in the powerhouse. A 100-kW emergency generator is located in the electrical room (elevation 1,580) in monolith 25 for supplying power for operation of spillway and outlet gates during an interruption in the regular power supply.

d. Multilevel Selector Gates.

The power intakes are equipped with adjustable gates for selective withdrawal of water from full pool elevation 1,600 to minimum pool elevation 1,445. The selector gate withdrawal system is used to discharge water at a temperature suitable for fish production at the downstream Dworshak National Fish Hatchery. Initial and future selector gate installations are located in monoliths 21 to 26, inclusive, and adjacent to the spillway and outlets. The plan, elevation, and section of the selector gate structure are shown on Plate 2-5.1. The as-built installation of selector gates is located in monoliths 24, 25, and 26 for the two 90-MW units and the single 220-MW unit, respectively. Future selector gates will be installed in the power intake structures of monoliths 21, 22, and 23. The penstock for the future units, nos. 4, 5, and 6, is closed on the upper end by a welded steel hemispherical bulkhead. The power intakes have a hydraulic capacity of 2,600 cfs each of the 90-MW units and 6,000 cfs for the 220-MW unit.

The 90-MW units are equipped with two selector gates - one master and one slave. The 220-MW unit is equipped with three selector gates - one master and two slaves. Each gate assembly (175-foot string) has been selected for fit and should not be considered to be interchangeable with any other 175-foot string. Nor is any segment of a gate assembly considered interchangeable with any other segment in the 175-foot string. Each gate assembly is 17 feet 3 inches wide by 175 feet long and is composed of eight segments with overall dimensions of 21 feet 1-½ inches long and a 6-foot top segment. The selector gates are a welded structural steel assembly and slide in stainless steel guides, which are embedded in concrete piers from elevations 1,290 to 1,613.5. Each selector gate assembly is equipped with an independent hoisting mechanism. The position of each gate is indicated on the gate hoist drum. The slave gate follows the movement of the master gate, and position of these gates is normally the same. A differential setting between the master and slave gates can be set manually, if necessary. The selector gate assembly for each power intake can either be operated manually from the top of the dam or remotely from the powerhouse control room. The amount of gate submergence (pool elevation minus top of gate elevation) is displayed in the control room. The design lifting speed of the selector gate varies from 2 to 4 feet per minute depending on the gate position.

The selector gate design is such that water either flows over the top of the gate (overshot) or under the bottom of the gate (undershot). The reservoir elevation range for an overshot operation is 1,500 to 1,600. During the overshot operation, the selector gate covers the intake opening completely, and a minimum design submergence restriction of 30 feet must not be violated. Gate submergence of less than 30 feet will starve the turbine and result in excessive differential head on the gate. Therefore, a minimum operating submergence of 35 feet will be adhered to unless otherwise directed. There is no restriction on greater submergence except that the top of the gate should not be lowered past elevation 1,465 since this is the effective wire rope limit on the gate hoist. See Plate 2-5.2 and Plate 2-5.3 for examples of typical gate positions for overshot operation.

For the undershot operation, the reservoir elevation range can be 1,445 to 1,600. The gate position is constant with the gate top elevation at 1,610 and the bottom elevation at 1,435. This setting provides a 40-foot flow opening under the gate. During the undershot operation, the selector gate must not be lowered because any lowering of the gate reduces the required 40-foot flow opening, starves the turbine, and causes excess differential head on the gate. Plate 2-5.4 shows the selector gate position during undershot operation.

Twenty-one temperature sensors located along the upstream face of the dam determine the water column temperatures immediately upstream of the dam. T1 through T4 are floating sensors and follow reservoir fluctuations. T5 through T21 are located at fixed elevations. In addition, one temperature sensor, T-21, is located on the downstream side of the dam on the pier nose of powerhouse bay number 2. These temperature sensors are read at least once a day from Monday through Friday by the project personnel. The following tabulation lists the Dworshak temperature sensor locations:

| Temperature Sensor | Measurement Elevation (ft. msl) |
|---|---|
| T1 | 1 ft. below pool elevation |
| T2 | 5 ft. below pool elevation |
| T3 | 10 ft. below pool elevation |
| T4 | 20 ft. below pool elevation |
| T5 | 1,574 |
| T6 | 1,549 |
| T7 | 1,524 |
| T8 | 1,499 |
| T9 | 1,474 |
| T10 | 1,449 |
| T11 | 1,424 |
| T12 | 1,399 |
| T13 | 1,374 |
| T14 | 1,349 |
| T15 | 1,324 |
| T16 | 1,299 |
| T17 | 1,249 |
| T18 | 1,199 |
| T19 | 1,149 |
| T20 | 1,099 |
| T21 | 1,049 |
| (PIER NOSE - POWERHOUSE BAY NO. 2) | 950 |

e. Power Facilities.

An indoor-type powerhouse encloses the turbine-generator units, assembly area, control room, and maintenance facilities. Initial installation includes two 90-MW generating units and one 220-MW generating unit. Skeleton facilities are provided for future installation of three additional 220-MW units. The Francis-type turbines for the 90-MW units are set at centerline distributor set at 975. The synchronous speed of the small units is 200 rpm, and 128.6 rpm for the large unit. Penstocks for the small units are 12 feet in diameter and 19 feet for the large units. Also, two 350-ton capacity bridge-type cranes are provided to facilitate assembly and maintenance of the units. Turbine generator unit rating curves are shown on Table 2-3 and Table 2-4 and graphically on Plate 2-6.1 and Plate 2-6.2. Powerhouse plans at elevations 988 and 1,005 are shown on Plate 2-6.3. Transverse sections of the 90-MW units and the 220-MW units are shown on Plate 2-6.4 and Plate 2-6.5, respectively.

The control room structure houses equipment rooms, operating personnel, and visitor facilities. The powerhouse is protected against floodwater up to elevation 1,005, which corresponds to the powerhouse main floor elevation (see Plate 2-6.4 for details). The regulated winter standard project flood is 75,000 cfs, which corresponds to a computed tailwater elevation of 996.5 at a point 1,000 feet below the axis of the dam with thalweg of 962 (see Plate 2-7, Tailwater Rating Curves at River Mile 1.69, and Plate 2-8, Tailwater Rating Curves at Powerhouse).

f. Reservoir.

Dworshak Reservoir lies within narrow, steep canyons of the North Fork Clearwater River. The reservoir extends 53.6 miles upstream of the North Fork at full pool elevation 1,600 feet msl. There are two major tributary arms on the right bank - Elk Creek, about 7 miles long, and Little North Fork, nearly 6 miles long. The reservoir's shoreline is 175 miles at full pool. The widest sections of the reservoir are in the lower one-third of its length, where the widths range generally from about ½ to 1 mile with the widest point at the mouth of Elk Creek being nearly 2 miles. The upper two thirds of the reservoir is much narrower, ranging mostly between 1,000 and 2,000 feet. The following tabulation outlines key reservoir elevations and capacity allocations.

**DWORSHAK RESERVOIR**

| Reservoir Element | Elevation |
|---|---|
| Crest of Dam | 1,613.0 |
| Maximum Design Water Surface | 1,604.9 |
| Normal Full Pool | 1,600.0 |
| Top of Inactive Pool | 1,445.0 |
| Top of Dead Storage Pool | 1,350.0 |
| Streambed at Dam Axis | 970.0 |

| Storage Element | Allocation | Elevation Range |
|---|---|---|
| Freeboard | 1,604.9 to 1,613.0 | 8.1 Feet |
| Surcharge | 1,600.0 to 1,604.9 | 92,000 A.F |
| Total Active Capacity | 1,445.0 to 1,600.0 | 2,016,000 A.F |
| Inactive | 1,350.0 to 1,445.0 | 682,000 A.F |
| Dead | 970.0 to 1,350.0 | 770,000 A.F |
| Total Capacity | 970.0 to 1,600.0 | 3,468,000 A.F |

Table 2-5 lists the elevation-capacity-surface area data. The reservoir configuration is shown on Plate 2-9.

g. Shoreline and Shoreline Access

. The region surrounding the reservoir, comprising much of the St. Joe and Clearwater National Forests, is a vast mountainous area without well-developed, all-weather public roads. Most of the right bank of the reservoir has south-facing slopes with scattered outcroppings of timber, while the left bank with generally northerly slopes supports a moderately dense forest growth. There is a rather extensive network of private logging roads which are mostly unsurfaced, strictly dry-weather roads on which public traffic is permitted except during periods of high fire hazard. Its extreme inaccessibility is a dominant characteristic of the Dworshak Reservoir area. Public access to the reservoir shoreline by roadway is available at only six locations. Two bridges were constructed across the reservoir as part of the project development. They are Dent Bridge at river mile 16.8 and Grandad Bridge at river mile 40.5. There are no fixed-wing aircraft landing strips within the project boundary, but a marked heliport is located near the left abutment of the dam. Plate 2-9 shows land use classifications of project lands around the reservoir for specific uses.

h. Fish Hatchery.

Dworshak does not have fish passage facilities; consequently, migrations of anadromous fishes are blocked at that location. In order to mitigate these fish losses and resident fish losses, a steelhead fish hatchery has been constructed on the point of land between the North Fork and the main stem of the Clearwater. The Dworshak National Fish Hatchery is the world's largest steelhead trout hatchery and is completely automated. The multilevel selector gates at Dworshak are used to control project discharge temperatures that are suitable for hatchery use. In addition, the hatchery is equipped to warm or cool water as necessary to maintain desired water temperatures in the rearing ponds.

The hatchery's annual production goal is 520,000 pounds of fish; 420,000 pounds will be steelhead smolts which are necessary to ensure sufficient adult returns annually to the hatchery. The additional 100,000 pounds will be freshwater fish, rainbow and kokanee, for reservoir planting to mitigate resident fishery losses. Since the hatchery began operation in October 1968, annual production goals have not yet been fully achieved because of various factors such as fishery diseases, insufficient run size, and equipment malfunction. The following tabulation is a summary of the hatchery's total annual production from 1970 to 1984.

| DWORSHAK NATIONAL FISH HATCHERY PRODUCTION RECORDS | | | | | |
|---|---|---|---|---|---|
| Fall | | | | | |
| Year | Steelhead (lbs.) | Kokanee (lbs.) | Rainbow (lbs.) | Cutthroat (lbs.) | Chinook (lbs.) |
| 1970 | 189,871 | None | None | None | None |
| 1971 | 415,046 | None | None | None | None |
| 1972 | 168,983 | 10,176 | 99,941 | None | None |
| 1973 | 306,833 | 393 | 132,416 | None | None |
| 1974 | 519,967 | 1,999 | 17,559 | 2,285 | None |
| 1975 | 291,676 | 2,368 | None | 80,090 | None |
| 1976 | 211,736 | 1,514 | 93,794 | 856 | None |
| 1977 | 236,728 | 1,113 | 24,167 | None | None |
| 1978 | 277,259 | None | 53,618 | None | None |
| 1979 | 153,770 | 985 | 92,746 | None | 371 |
| 1980 | 339,638 | None | 49,000 | None | None |
| 1981 | 279,189 | None | 56,791 | None | None |
| 1982 | 344,682 | None | 73,380 | None | None |
| 1983 | 317,685 | None | 60,136 | None | None |
| 1984 | 338,847 | None | 22,109 | None | None |

i. Log Handling Facilities.

Commercial navigation on Dworshak is an authorized project function for log handling operations. Four log dumping sites are available and are located as follows: Little Meadow Creek site (located on the left bank of the North Fork Clearwater River at river mile 37.3), Robinson Creek site (located on the right bank of the North Fork Clearwater River at river mile 39.3), Breakfast Creek site (located on both banks of the Little North Fork near the confluence of Breakfast Creek), and Benton Creek site (on the left bank of the North Fork Clearwater River at river mile 43.5). Logs can be floated from these sites to the log handling ramp at the dam for removal. No special operations of the dam or reservoir are anticipated for log handling operations. Operating pool levels for log dumping and log removal are shown in the following tabulation.

| Site | Operational Pool Range |
|---|---|
| Little Meadow Creek (log dump) | 1,570-1,600 |
| Robinson Creek (log dump) | 1,565-1,600 |
| Breakfast Creek (log dump) | 1,570-1,600 |
| Benton Creek (log dump) | 1,565-1,600 |
| Dworshak Log Handling Facility | 1,445-1,600 |

2-04 Related Control Facilities.

There are no control facilities associated with this project.

## 2-05 Real Estate Acquisition.

The Dworshak Dam and Reservoir project contains approximately 30,935 acres of public land. As part of the project, a land use plan has been developed for guiding the development and management of the lands surrounding the reservoir. The plan has project operation areas, recreation areas (which includes group camping areas), log handling areas, wildlife areas, natural areas, and National Forest land. Plate 2-9 shows the current land use plan. The following tabulation summarizes land use classifications for Dworshak project lands present and future developments.

| Land Use Areas (acres) | Present and Future Allocations |
|---|---:|
| Project Operation (including Dworshak Dam) | 298.8 |
| Recreation Intensive | 1,245.7 + 1,120.8 future |
| Recreation Low Density | 4,083.1 |
| Log Handling | 183.9 + 10.7 future |
| Wildlife Management Intensive | 11,643.1 |
| Wildlife Management Moderate | 9,749.4 |
| Natural Area | 982.5 |
| Natural Forest Land | 1,617.4 |
| Total | 30,935.4 |

## 2-06 Public Facilities.

Plate 2-9 shows the general location of existing recreation sites on project lands. The existing recreation sites and associated facilities and activities are listed as follows.

| Facilities | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | Fee Camp | Camping Unit | Picnic Units | Trailer Hookups | Boat Launch Ramps | Swim Area | Play Area | Hiking Trails | Toilets | Drinking Water | Showers | Handicapped | Amphitheater | Display |
| Big Eddy | | | 4 | | • | • | | • | • | | | • | | |
| Boehls | | 4 | | | | | | | • | | | | | |
| Bruces Eddy | | | | | • | | | | • | • | | • | | |
| Canyon Creek | | 12 | 2 | | • | | | | • | | | | | |
| Cold Springs | | | 4 | | | | | • | • | | | | | |
| Dent Acres | • | 50 | 6 | • | • | • | | • | • | • | • | • | | |
| Dent Orchard | | | 24 | | | | | • | • | | | • | | |
| Freeman Creek | • | 100 | 25 | • | • | • | • | • | • | • | • | • | • | • |
| Grandad Creek | | 6 | | | • | | | | • | | | | | |
| Little N. Fork | | 4 | | | | | | | • | | | | | |
| Magnus Bay | | 6 | | | | | | | • | | | | | |
| Merrys Bay | | | 3 | | | • | • | • | • | | | | | |

Detailed information on existing recreation sites can be found in the "Walla Walla District Recreation Facilities Guide," dated March 1984 and the "Dworshak Master Plan - Volume 1," dated July 1985. General information and reservoir elevations required for public use of the existing recreation sites are summarized in Table 2-6.

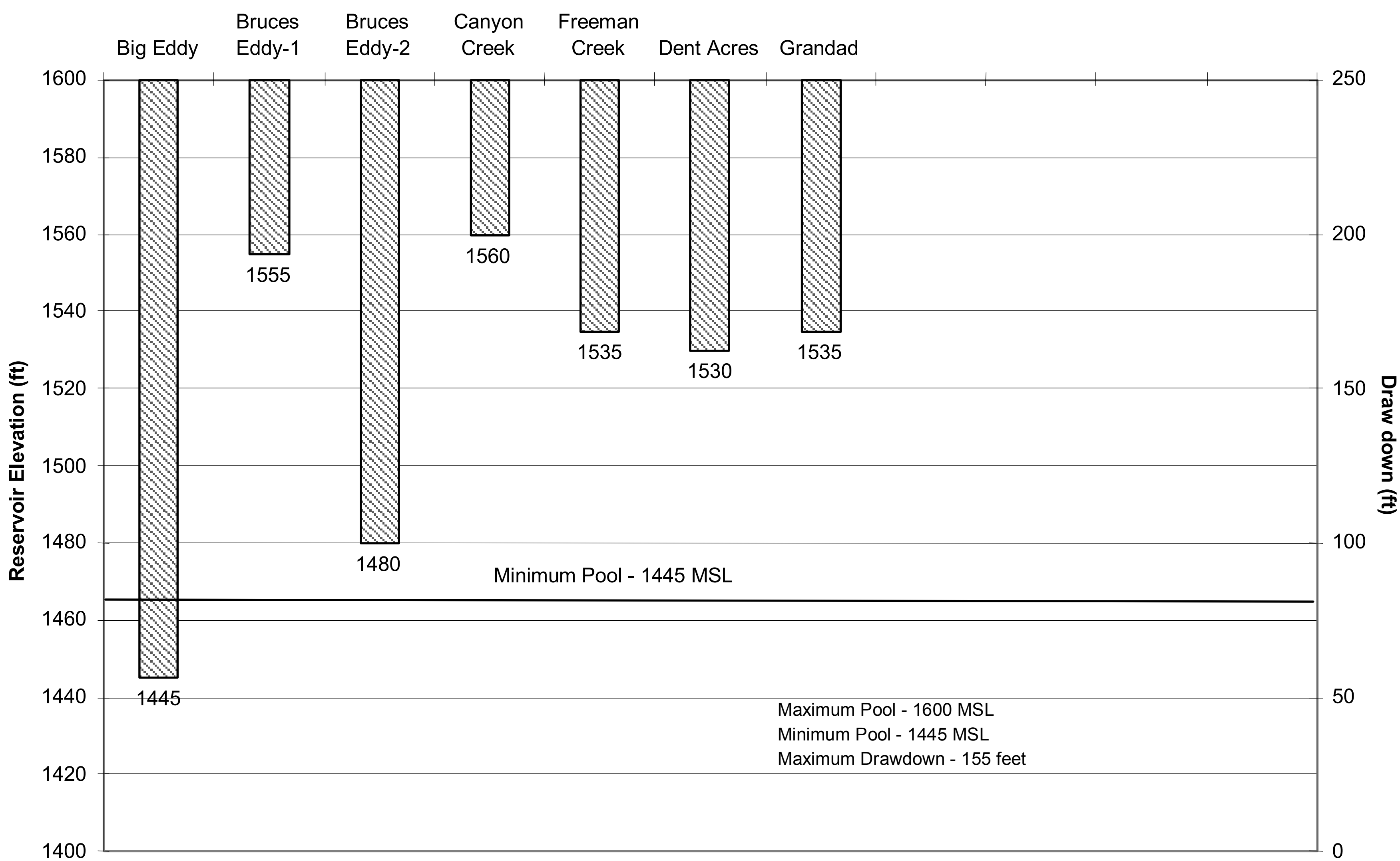
Guided tours of the dam itself begin at the visitor center, and the displays at the visitor center include audiovisual formats. Boat moorage, boat fuel, and concessions are available at the Big Eddy site. Boat tie-up docks are available at the right abutment area for boater access to the visitor center and at all boat launching ramps except Grandad Creek. In addition, the Dworshak National Fish Hatchery, with visitor center and fish facilities, provides additional day-use only opportunities for visitors to the Dworshak Project.

The Three Meadows site is a group camp only. Facilities include two trailer pads with hookups, eight cabins, a lodge, restrooms, showers, and utilities. Occupancy at Three Meadows is by reservation through a lease holder. A group camp section with recreational vehicle pull-through pad sites (no hookups) is available at the Freeman Creek site in an area separate from the individual units. Occupancy at Freeman Creek is by reservation through the Corps of Engineers, telephone number (208) 476-5994 or Idaho's Dworshak State Park. Cold Springs is intended primarily to be used as a primitive group camp which is accessible either by trail or boat. Facilities include chemical toilets and sparsely developed group tent areas.

All initial development of Dworshak Project recreation facilities has been completed. Recreation development on project lands to date (1986) has been the responsibility of the Corps of Engineers.  However, the Federal Water Project Recreation Act now requires cost-sharing on all future development of new recreation areas, such as those covered by the Dworshak Master Plan's land use classification, "Future Intensive Use Recreation Sites."  An exception to the cost-sharing requirement is new development by the Forest Service on project lands within National Forest boundaries.  In addition, non-Federal participation in future recreation development will be required if the Dworshak Project should be designated as a National Recreation Area.

There are many recreation sites in the region which offer recreational opportunities similar to those on Dworshak Project lands.  Regional recreation sites as shown on Plate 2-10.  Camping and water-oriented activities are the primary uses of Dworshak Project lands.  Dworshak's recreation sites and other sites in the region receive high seasonal use..

## Figure 2-1 Boat Launch Ramps - Usable Access



# 3 HISTORY OF PROJECT

3-01 Authorization.

3-02 Planning and Design.

Early planning of Dworshak Dam and Reservoir referred to the project as “Bruce’s Eddy Project.” The name was changed by Congressional action in August 1963 in honor of the late Senator Henry C. Dworshak of Idaho. The history of the project can become known in a comprehensive manner by review of the tabulation, “Dworshak Historical Data,” which follows. If additional information is desired, obtain a copy of the “Historical Report on Construction, Dworshak Dam and Reservoir, North Fork Clearwater River, Idaho,” from the Walla Walla District Library.

Contributions from Dworshak. Dworshak is a major storage project in the Columbia River system. It has sufficient storage to provide regulation in the interest of downstream flood control, system power generation, water quality, recreation, and other requirements. Dworshak’s operation in conjunction with the total system of Columbia River reservoirs contributes to the reduction of floods on the lower Columbia River, maximizes power generation on a system basis, and provides significant recreation benefits to the local area and the region.

3-03 Construction.

| DWORSHAK HISTORICAL DATA | |
|---|---|
| **Date** | **Item** |
| 20 Mar 1950 | House Document 531, 81st Congress, 2nd Session, titled “Columbia River and Its Tributaries, Northwestern United States,” proposed a main control plan of reservoirs in the Columbia River system and discussed Bruce’s Eddy Project on the North Fork Clearwater River as a potential project in addition to that plan. |
| 14 Jun 1955 | Senate Document 51, 84th Congress, 1st Session, Review Report (Review of House Document 531) - Middle Snake River and Tributaries (Lewiston to Pittsburg Landing), Idaho, Oregon, and Washington, recommended adoption of Bruce’s Eddy Project on the North Fork Clearwater River. |
| 3 Jul 1958 | Public Law 85-500, 85th Congress, 2nd Session, provided authority and funds for detailed planning for the Bruce’s Eddy Dam and Reservoir. |
| Oct 1958 | First planning money. |
| 4 Nov 1958 | First exploratory drilling. |
| 10 Aug 1960 | First contract with Idaho Fish and Game on elk browse. |
| 28 Mar 1969 | First contract with Fish and Wildlife Service on fish and wildlife studies. |
| 7 Dec 1961 | Tunnel drilling for exploration. |
| 8 Mar 1962 | First contract with Idaho Fish and Game on steelhead. |
| 23 Oct 1962 | Public Law 87-874, Section 201 of the Flood Control Act of 1962 in accordance with House Document 403, 87th Congress, 2nd Session, provided construction authorization. |

| | |
|---|---|
| 23 Apr 1963 | First access road contract to right abutment. |
| Aug 1963 | Project name changed from Bruce's Eddy, Public Law 88-96. |
| 6 Dec 1963 | First project network analysis. |
| 23 Mar 1964 | First clearing contract. |
| 15 May 1964 | First fire protection agreement on project. |
| 8 Jun 1964 | First power line relocation, Clearwater Power Company. |
| 4 Jan 1965 | Diversion tunnel contract. |
| 19 Jan 1965 | First road relocation agreement, County on Detour Road. |
| 30 Mar 1965 | Access-detour roads contract. |
| 13 Sep 1965 | Resident office contract. |
| 15 Mar 1966 | Dam temporary fish facility contract. |
| 20 May 1966 | First explorations for Dent Bridge. |
| 6 Jul 1966 | Second clearing contract. |
| 20 Jul 1966 | Main dam contract. |
| 7 Sep 1966 | State highway to project improvement contract. |
| 5 Apr 1967 | First seeding of reservoir clearing area. |
| 11 Jul 1967 | Hatchery main pumps contract. |
| 27 Jul 1967 | Third reservoir clearing contract. |
| 8 Sep 1967 | Hatchery main contract. |
| 15 Mar 1968 | Powerhouse turbines contract. |
| 25 Apr 1968 | Permanent fire protection agreement for project. |
| 6 May 1968 | Right abutment road to Dent Bridge contract. |
| 8 May 1968 | Granddad Bridge design contract. |
| 17 May 1968 | Left abutment road to Dent Bridge contract. |
| 22 Jun 1968 | First bucket of concrete in dam. |
| 25 Aug 1968 | Bureau of Sport Fisheries assigned first hatchery personnel (two-man). |
| 2 Oct 1968 | Hatchery-held first steelhead (21). |
| 15 Oct 1968 | Hatchery housing contract. |
| 29 Apr 1969 | Hatchery spawned first eggs. |
| 28 May 1969 | 1 million cubic yards concrete in dam. |
| 16 Jun 1969 | First school aid contracts (Lewiston, Orofino, and Kamiah). |
| 24 Oct 1969 | 2 million cubic yards concrete in dam. |
| 25 Nov 1969 | Hatchery personnel agreed to operate permanent fish facilities. |
| 3 Dec 1969 | Powerhouse permanent fish pump contract. |
| 4 Dec 1969 | Dent Bridge contract. |
| 31 Dec 1969 | Powerhouse bridge cranes contract. |
| 28 Jan 1970 | Powerhouse generators contract. |
| 31 Mar 1970 | 3 million cubic yards concrete in dam. |
| 7 Apr 1970 | Powerhouse contract. |
| 19-20 Apr 1970 | Hatchery released first smolts (1.4 million). |
| May 1970 | Hatchery gave 1970 eggs = 2.5 million to state, 200,000 to Oregon, 500,000 to Russia. |
| 8 May 1970 | 4, 5, and 6 clearing contract, flotation method. |
| 12 Jun 1970 | Powerhouse transformers contract. |
| 8 Jul 1970 | First report of columnaris disease in hatchery. |
| 16 Jul 1970 | Granddad Bridge contract. |
| 13 Aug 1970 | 4 million cubic yards concrete in dam. |
| 21 Oct 1970 | Powerhouse governors contract. |
| 23 Feb 1971 | 5 million cubic yards concrete in dam. |

| | |
|---|---|
| 15, 16, 17 Mar 1971 | Hatchery smolt release, 3.1 million. |
| 23 Apr 1971 | Stockpiling sand and topsoil contract. |
| May 1971 | Last PFI log drive. |
| 21 Jun 1971 | Second phase log handling contract. |
| 27 Jul 1971 | Upper reservoir roads contract. |
| 13-17 Sep 1971 | Placed diversion tunnel closure gate. |
| 21 Sep 1971 | Big Eddy launching ramp contract. |
| 27 Sep 1971 | Slide gates in closure gate closed. |
| 2 Oct 1971 | Last deck pour on Dent Bridge. |
| 29 Oct 1971 | Dent Bridge opened to one-way traffic. |
| 8 Nov 1971 | Water diversion changed from tunnel to temporary low-level outlet. |
| 9 Nov 1971 | 6 million cubic yards concrete in dam. |
| 18 Nov 1971 | Steel closed on Granddad Bridge. |
| 4 Jan 1972 | Dam selector gates contract. |
| 11 Feb 1972 | Breached downstream cofferdam. |
| 14 Feb 1972 | Maindam gantry crane contract. |
| 17 Feb 1972 | Diversion tunnel plug completed. |
| 12 Mar 1972 | North Fork fish barrier removed. |
| 12 Mar 1972 | Regulating outlets opened and temporary low-level outlet closed. Released first of 100,000 pounds of rainbow and kokanee in reservoir. |
| 18 Mar 1972 | First fish collection in powerhouse trap (15 pounds). |
| 14 Apr 1972 | Hatchery Phase II contract. |
| 17-20 Apr 1972 | Hatchery released 1 million smolts of 1970 brood. |
| 17 Oct 1972 | Granddad Bridge and Upper Reservoir Roads opened to traffic. |
| 26 Jan 1973 | Dam concrete topped out - 6,626,245 cubic yards. |
| 30 Jan to 1 Mar 1973 | Released 100,000 pounds of rainbow in reservoir. |
| 1 Mar 1973 | Unit 1 first placed on line. |
| 6 Mar 1973 | Hatchery sculpture contract awarded. |
| 16 Mar 1973 | First steelhead spawning, 1,156 fish processed (5 weeks early). |
| 6 Apr 1973 | Unit 2 placed on line. |
| 20 Apr 1973 | Unit 3 placed on line. |
| 8 May 1973 | Hatchery completed processing 6,997 adults (4,708 female) and took 28,211,000 eggs. |
| 31 Jul 1973 | Unit 1 selector gate in operation. |
| 3 Aug 1973 | Unit 2 selector gate in operation. |
| 18 Aug 73-Slot A) | Unit 3 selector gate in operation. |
| 16 Oct 73-Slot B) | |
| 15 Nov 73-Slot C) | |

## 3-04 Related Projects.

## 3-05 Principal Regulation Problems.

Since the project began operation in March 1973, two major problems have occurred at Dworshak.

a. The first problem, discovered December 1975, concerns an extensive erosion in the stilling basin. Investigation of the erosion problem by the Walla Walla District revealed that damage had occurred in the stilling basin because of two factors:

(1). Large amounts of construction debris deposited in the stilling basin prior to and during initial operation.

(2). Unbalanced flow pattern into the stilling basin caused the debris in the basin to be churned about and eroded the concrete. Unbalanced flow can also draw material into the stilling basin from downstream. As a result, a uniform flow pattern is recommended at all times through the spillway stilling basin.

b. The second problem pertained to leakage from a crack which developed in monolith 35 during June 1980. No special regulation at Dworshak was required because the plan of action taken by the Walla Walla District resulted in a significant reduction in the volume of water that had been entering the crack. The corrective measures taken were as follows:

(1). Drilling drain holes in order to relieve crack pressure and define crack limits.

(2). Installing two vinyl curtains temporarily.

(3). Filling crack with epoxy mixture.

(4). Filling crack with cinders.

c. During the period 3 June 1980 to 11 March 1981, 33 flow measurements were made at the gallery 1160 measuring site. Flows decreased from a maximum of about 17.5 cfs on 8 June 1980 to 0.7 cfs on 11 March 1981. Conditions at the gallery 1160 site have remained stable since March 1981. During 18-25 March 1982, more extensive repair work was accomplished with an epoxy mixture. No further repair on the crack has been required.

# 4 WATERSHED CHARACTERISTICS

4-01 General Characteristics.

The Clearwater River at Spalding has a total drainage area of approximately 9,570 square miles. It is located in north central Idaho and is a major tributary of the Snake River, which is a principal branch of the Columbia River. The basin elevation ranges from about 750 to 9,000 feet msl and has a median elevation of 4,500 feet msl. Adjacent river basins are the St. Joe and St. Regis to the north, Bitterroot to the east, and Salmon to the south. Principal streams within the Clearwater River Basin generally flow in a westerly direction. The North Fork of the Clearwater River joins the main stem of the Clearwater downstream of Orofino and enters the Snake River at Lewiston, Idaho. Topography and runoff characteristics naturally divide the Clearwater River Basin into two principal drainage areas, which will be referred to as the Upper and Lower Clearwater River watersheds for purposes of this manual. Plate 4-1 shows a basin map for the North Fork Clearwater River above Dworshak Dam.

4-02 Topography.

a. Upper Watershed. The upper watershed consists of 8,040 square miles of drainage area above Peck, Idaho, and represents about 85 % of the total area above Spalding. Major subbasins within the upper watershed are: (1) North Fork - 2,440 square miles, (2) South Fork - 1,200 square miles, (3) Lochsa River - 1,180 square miles, and (4) Selway River - 1,910 square miles. These four basins contain approximately 70 % of the total area above Spalding. The upper watershed is topographically rugged with streams deeply entrenched below mountains, V-shaped valleys, steep-sloped mountains, and narrow, sharp ridges. Elevation within the upper watershed varies from about 950 to 9,000 feet msl, and the median elevation is 5,000 feet msl.

The general course of the North Fork is westerly from the Bitterroot Range in the eastern and northeastern areas of the basin. The North Fork flows into the Clearwater River about 40 miles east of Lewiston, Idaho, and drains a topographically rugged, densely timbered, sparsely populated, and largely undeveloped area of 2,440 square miles above the dam. The North Fork contains approximately 25 % of the 9,570 square miles of drainage area above Spalding, Idaho, and 2 % of the 103,500 square miles of drainage above Lower Granite Dam.

b. Lower Watershed. The lower watershed consists of approximately 1,530 square miles of drainage area between the Peck and Spalding gauging stations. The lower watershed contains about 16 % of the 9,570 square miles of drainage area above Spalding. Principal tributaries in the lower watershed are: (1) Lapwai Creek - 235 square miles, (2) Potlatch River - 425 square miles, and (3) Big Canyon Creek - 225 square miles. These three tributaries contain approximately 9 % of the total drainage area above Spalding. The lower watershed consists of generally steep, barren hills and plateaus intersected by cultivated valleys. The plateaus are generally composed of rolling hills, and extensive areas are adapted to raising principal crops of wheat, peas, and lentils by dry-farming methods.

The Scenic Rivers Unit, Water Resources Research Institute, University of Idaho, published "An Environmental Survey of the Lower Clearwater River," dated 31 July 1970. This report gives a detailed description of the lower watershed from Ahsahka to Lewiston.

## 4-03 Geology and Soils.

The headwaters of the North Fork Clearwater River and its tributaries originate in a mountainous area underlain by metamorphic rocks of the Belt Series and igneous granitic rocks of the Idaho Batholith. Rock types underlying the drainage basin are of considerable variety. This is a result of mode of origin; for example, the Belt Series are metamorphic sediments and consist of quartzites, argillites, and impure limestones, while the Idaho Batholith is composed of igneous rocks of the granite series. Figure 4-1 shows the general distribution of these rock types. The lower course of the river valley walls is metamorphic rocks in the Orofino Series. Locally, there are igneous intrusions with quartz veins being quite numerous and basaltic dikes less common. In the eastern and northern parts of the basin, these metamorphics are typical of the Belt Series and still display many of the features of the original sediments from which they have been altered. In the western part of the North Fork Basin, the lavas of the Columbia Plateau occur at various locations. These are locally associated with shales between lavas and the older, underlying rocks. The Belt Series strata are of pre-Columbian age, and the Idaho Batholith granites of the Mesozoic era are intruded into them. The Orofino Series metamorphosed rock surround the intrusive granite. The older formations were uplifted and folded during the period of mountain formation, giving rise to the Bitterroot Range of the Rocky Mountains. Lava flows of the Miocene age locally blocked the drainage. Lakebed-type sediments, clay, and fine-grained materials were deposited and are found below and between the lava. These deposits are known as the Latah Formation. The lava flows changed the original drainage pattern of the basin, and the present course of the North Fork Clearwater River cuts across the pattern of old valleys and

## 4-04 Sediment.

Because of the character of geological formations in the drainage area, the relative scarcity of topsoil, and the nature of runoff, the suspended sediment in the Clearwater River is relatively low. Physical evidence indicates there is significant movement of coarser bed load material during high flows but, in general, the stream is one of the lesser sediment transporting streams in the region. Based on measurements of other streams in the region, it is estimated that the average annual sediment load of the North Fork at Dworshak will be on the order of 300 acre-feet per year. Because this is very low and no problems are expected to result from sediment accumulation, there is no program for sediment measurements.

4-05 Climate.

The climate of the Clearwater Basin is characterized by mild summers, long, cold winters, and an abundance of snowfall which accumulates in snow packs generally from November through April. The area is dominated by moist Pacific maritime air masses which are moved over the basin by prevailing westerly winds. Although these air masses have lost much of their precipitable water in passing over mountains further west, they still contain sufficient moisture that they experience the orographic effect within the basin and yield considerable precipitation. During the winter, polar air masses occasionally enter the basin from the north and displace maritime air masses, producing short periods of extremely low temperatures. Plate 4-1 shows the locations of stream flow, precipitation temperature, and snow stations within the basin.

The following paragraphs discuss and outline temperature, precipitation, snow, and evaporation data for stations within and adjacent to the Clearwater River Basin. These stations are the hydrologic stations which are used to estimate runoff volumes and supply real-time data necessary for the regulation of Dworshak Reservoir.

a. Temperature. Temperature records for: (1) Avery Ranger Station, (2) Elk River, (3) Headquarters, (4) Mullan, (5) North Star Ranch, (6) Orofino, (7) Pierce, and (8) Powell have been summarized. Table 4-1 lists extremes for average maximum daily temperatures by month for these stations, and Table 4-2 lists extremes for average minimum daily temperatures by month. Temperatures within the Clearwater Basin can vary with extreme fluctuations from month to month and year to year. Table 4-3 shows temperature extremes which have occurred at these key hydrologic stations.

b. Precipitation. Plate 4-1 defines the isohyetal pattern of mean annual precipitation over the drainage areas of the North Fork Clearwater River Basin. The mean annual precipitation values vary from 24 inches near the mouth of the North Fork to 70 inches near the summit of the Bitterroot Mountain Range. Monthly precipitation records for key hydrologic stations: (1) Avery Ranger Station, (2) Elk River, (3) Headquarters, (4) Mullan, (5) North Star Ranch, (6) Orofino, (7) Pierce, and (8) Powell are listed on Table 4-4. The precipitation amounts recorded at these key hydrologic stations have a seasonal distribution where, on the average, 60 to 70 % of the total October to September water year precipitation occurs during the months of October to March, 20 to 30 % during the months of April to July, and 5 to 15 % during the months of August to September. Large amounts of precipitation will have a significant effect on the regulation of Dworshak Reservoir. Table 4-5 shows maximum 24-hour precipitation accumulations which have occurred at these key hydrologic stations during the period of record.

| TABLE 4-5 MAXIMUM 24-HOUR PRECIPITATION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Month** | **Avery R.S. 2**[1] | **Elk River 1S**[2] | **Headquarters**[3] | **Mullan**[4] | **North Star Ranch**[5] | **Orofino**[6] | **Pierce**[7] | **Powell**[8] |
| Jan | 1.66 | 2.01 | 1.71 | 4.40 | 1.43 | 1.73 | 1.68 | 1.55 |
| Feb | 1.25 | 2.44 | 1.57 | 1.70 | 1.05 | 1.68 | 2.07 | 1.39 |
| Mar | 0.97 | 1.32 | 1.75 | 1.10 | 0.68 | 2.13 | 1.30 | 1.26 |
| Apr | 1.07 | 1.92 | 1.79 | 0.80 | 1.42 | 1.40 | 1.67 | 2.13 |
| May | 1.50 | 1.98 | 1.13 | 1.46 | 1.13 | 1.61 | 1.66 | 1.73 |
| Jun | 1.35 | 1.68 | 1.81 | 1.47 | 1.05 | 2.20 | 1.63 | 1.66 |
| Jul | 1.27 | 1.47 | 1.57 | 1.25 | 1.07 | 2.77 | 1.78 | 1.02 |
| Aug | 1.10 | 2.26 | 1.49 | 1.20 | 1.24 | 1.38 | 2.05 | 1.32 |
| Sep | 1.83 | 1.20 | 1.43 | 0.94 | 1.13 | 1.99 | 1.25 | 1.80 |
| Oct | 0.89 | 1.45 | 1.93 | 1.17 | 1.18 | 1.38 | 1.43 | 1.70 |
| Nov | 1.33 | 2.32 | 1.66 | 1.80 | 1.11 | 1.57 | 1.43 | 1.82 |
| Dec | 2.80 | 2.00 | 2.00 | 1.58 | 1.93 | 2.29 | 2.30 | 2.73 |

[1] Period of Record, 1968-1981, 14 years, station elevation 2,390 feet msl.
[2] Period of Record, 1952-1981, 30 years, station elevation 2,918 feet msl.
[3] Period of Record, 1959-1981, 23 years, station elevation 3,138 feet msl.
[4] Period of Record, 1972-1981, 10 years, station elevation 3,317 feet msl.
[5] Period of Record, 1967-1981, 15 years, station elevation 2,800 feet msl.
[6] Period of Record, 1903-1981, 79 years, station elevation 1,027 feet msl.
[7] Period of Record, 1963-1981, 19 years, station elevation 3,185 feet msl.
[8] Period of Record, 1962-1981, 20 years, station elevation 3,632 feet msl.

Source: Climatological Data for Idaho, Publication of the National Oceanic and Atmospheric Administration.

Most of the annual precipitation within the Clearwater River Basin occurs as rainstorms which move generally eastward across the basin. However, during the warmer months, precipitation can occasionally occur from thunderstorms. These thunderstorms are usually of short duration and not continuous over large areas of the basin, but precipitation intensities can be very high over small areas. The December 1933 rainstorm was the most severe general rainstorm that has occurred in the North Fork Clearwater River Basin since 1926 and produced the highest flow of record, 100,000 cfs on 23 December 1933, at the Ahsahka gage. During the period 17 to 25 December, a series of storms occurred and basin precipitation was estimated to have averaged nearly 8 inches, with some precipitation almost continuously in the period but with maximum intensities probably not exceeding two-tenths of an inch per hour. There have probably been more intense storms than that of December 1933, but no other has produced as high a runoff in the North Fork Clearwater at Dworshak and the main stem at Spalding since the beginning of stream flow records in 1926.

c. Snow. Snow accumulation in the Clearwater River Basin generally begins in late September or October and continues to increase in water content until April or May. The amount of water content accumulation varies from year to year and is influenced by the amounts of precipitation, the sequence of temperatures, and soil moisture conditions during the accumulation period. Table 4-6 summarizes 1961 to 1980, 20-year average, snow water content data for 11 stations used in the Dworshak runoff volume forecast procedure. The accumulation of snow over the Clearwater River Basin affects the forecasted runoff volume, which dictates the degree of regulation necessary and the manner in which Dworshak Reservoir is regulated.

The following tabulation compares the measured 1 April snow water content at the 11 snow courses with both the minimum and the maximum April through July inflow runoff volumes of record in the North Fork Clearwater River at Dworshak Dam.

| **1 APRIL SNOW COURSE WATER CONTENT** | | | |
|---|---|---|---|
| **Snow Course** | **Elevation (ft. msl)** | **1977 (in.)** | **1972 (in.)** |
| Crater Meadows | 5,960 | 25.5 | 71.7 |
| Crooked Fork | 3,610 | 9.0 | 22.0 |
| Elk Butte | 5,550 | 19.2 | 55.0 |
| Fish Lake Airstrip | 5,650 | 18.9 | 62.0 |
| Hemlock Butte | 5,810 | 26.8 | 77.2 |
| Hoodoo Basin | 6,000 | 23.0 | 80.8 |
| Hoodoo Creek | 5,900 | 22.4 | 78.3 |
| Lolo Pass | 5,240 | 15.4 | 52.3 |
| Lost Lake | 6,110 | 25.2 | 85.7 |
| Savage Pass | 6,170 | 15.4 | 42.9 |
| Shanghai Summit | 4,600 | 14.3 | 45.8 |
| North Fork Clearwater River at Dworshak Dam April-July Runoff Volume | | 1,238,900 A.F | 4,671,800 A.F |

| **TABLE 4-6**<br>**CLEARWATER RIVER BASIN AVERAGE SNOW WATER CONTENT**<br>**(20-Year Average - 1961-1980)** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Average Snow Water Content (inches) | | | | | | | |
| Station | Elevation (ft. msl) | 1 Jan | 1 Feb | 1 Mar | 1 Apr | 1 May | 1 Jun |
| Crater Meadows | 5,960 | 18 | 30.1 | 37.9 | 45.2 | 46.2 | 29.8 |
| Crooked Fork | 3,610 | 5.3 | 10.3 | 12.4 | 13.6 | 2.9 | -- |
| Elk Butte | 5,550 | -- | 26.7 | 33.3 | 37.2 | 31.7 | 8.9 |
| Fish Lake Airstrip | 5,650 | 6.9 | 27.2 | 35.2 | 39.9 | 40 | -- |
| Hemlock Butte | 5,810 | 0.5 | 33.8 | 42 | 49.6 | 50.1 | 29 |
| Hoodoo Basin | 6,000 | 0.1 | 34.8 | 44.6 | 52.7 | 54.5 | 36.3 |
| Hoodoo Creek | 5,900 | 7.8 | 32.4 | 41.8 | 49.2 | 50.7 | 35.6 |
| Lolo Pass | 5,240 | 2.1 | 21.5 | 27.4 | 31.8 | 30 | -- |
| Lost Lake | 6,110 | 2.2 | 38 | 48.5 | 58.3 | 59.1 | 43.4 |
| Savage Pass | 6,170 | 0.7 | 18.9 | 24.3 | 28.4 | 28.5 | -- |
| Shanghai Summit | 4,570 | 9.8 | 17.3 | 23.7 | 26.1 | 21.2 | -- |

Source: Water Supply Outlook for Idaho, U.S. Department of Agriculture, Soil Conservation Service, Boise, Idaho, 1985 Publication.

d. Evaporation. Evaporation losses within the Clearwater River Basin will vary with temperatures. Evaporation data is not available for key stations within the basin. However, Table 4-7 lists and summarizes total monthly evaporation rates for the University of Idaho at Moscow.

## 4-06 Storms and Floods.

Floods in the Clearwater River Basin are generally of two types: (1) spring snowmelt with or without spring rainstorms, and (2) winter rainstorms accompanied by snowmelt. The following paragraphs discuss pertinent floods for the key gauging stations of: (1) North Fork Clearwater at Dworshak, (2) Clearwater at Orofino, and (3) Clearwater River at Spalding.

(1). North Fork Clearwater at Dworshak. Floods in the North Fork Clearwater River at the Dworshak dam site with unregulated annual maximum mean daily discharges in excess of 35,000 cfs and coincident with damage conditions (approximately 100,000 cfs) in the lower Clearwater River at Spalding have occurred on 17 occasions since October 1926. Fifteen of these events were spring floods and two were winter floods. Table 4-8 summarizes the 15 spring snowmelt floods, and Table 4-9 summarizes the two winter floods in the North Fork at Dworshak dam site.

**TABLE 4-8**
**SPRING SNOWMELT FLOODS**
**SUMMARY OF UNREGULATED DISCHARGE AND RUNOFF AT DWORSHAK DAMSITE**

| Date | Maximum Mean Daily Discharge (cfs) | April-July Runoff Volume (Million A.F.)[1/] | Percent of Average April-July Runoff Volume |
|---|---|---|---|
| 17-May-27 | 35,700 | 3.434 | 124 |
| 10-May-28 | 39,600 | 3.329 | 120 |
| 14-May-32 | 38,400 | 3.567 | 129 |
| 10-Jun-33 | 44,000 | 3.430 | 124 |
| 19-Apr-36 | 37,200 | 3.085 | 111 |
| 18-Apr-38 | 53,200 | 2.698 | 97 |
| 29-May-48 | 52,000 | 3.917 | 141 |
| 15-May-49 | 41,300 | 3.491 | 126 |
| 21-May-56 | 40,600 | 3.909 | 141 |
| 21-May-57 | 36,000 | 3.166 | 114 |
| 08-Jun-64 | 35,100 | 3.402 | 123 |
| 30-May-71 | 43,000 | 4.046 | 146 |
| 31-May-72 | 51,900 | 4.672[2] | 168 |
| 05-Jun-74 | 45,300 | 4.651 | 168 |
| 06-May-79 | 40,200 | 2.691 | 97 |

[1] Average April-July runoff volume 2,776 million acre-feet based on 1927-1985 period of record.
[2] Largest spring snowmelt runoff volume for 1927-1981 period of record.

**TABLE 4-9**

**WINTER RAINSTORM AND SNOWMELT FLOODS**
**SUMMARY OF UNREGULATED DISCHARGE AND RUNOFF AT DWORSHAK**

| Date | Maximum Mean Daily Discharge (cfs) | Duration Above 35,000 cfs (Days) | Runoff Volume Above 35,000 cfs (A.F.) |
|---|---|---|---|
| 23 Dec 1933 | 90,000[1/] | 4 | 476,000 |
| 23 Dec 1964 | 54,000 | 2 | 192,000 |
| 30 Nov 1995 | 57,800 | | |
| 9 Feb 1996 | 59,000 | | |

[1] Largest mean daily peak discharges for 1927 – 1996 water year period.

(2). Clearwater River at Orofino. Floods in the Clearwater River at Orofino occur as natural or unregulated flow. Dworshak cannot provide flood protection for Orofino, but existing local levees provide some flood protection for frequent high flows. These local levees are not adequate for large floods that have peak discharges equal to or greater than flow damage conditions of approximately 95,000 cfs at Orofino. Peak discharges in excess of 95,000 cfs have not occurred during the period of record since October 1950. However, two flood peak discharges exceeding 95,000 cfs have occurred outside of the period of record for the Clearwater River at the Orofino gage. The largest flood peak discharge is estimated to be approximately 106,000 cfs and occurred on 28 May 1948. The second largest flood peak discharge is estimated to be approximately 99,700 cfs and occurred on 8 June 1964.

(3). Clearwater River at Spalding. Floods in the Clearwater River at Spalding with unregulated maximum mean daily discharges in excess of damage conditions (approximately 100,000 cfs) have occurred on 19 occasions since October 1910. During the October 1910 through September 1913 and October 1925 through September 1985 periods (56 years), 17 events were spring floods and two events were winter floods. Table 4-10 summarizes the 17 spring snowmelt floods and Table 4-11 summarizes the two winter floods.

| TABLE 4-10<br>SPRING SNOWMELT FLOODS<br>SUMMARY OF UNREGULATED DISCHARGE AND RUNOFF AT SPALDING | | | |
|---|---|---|---|
| Date | Maximum Mean Daily Discharge (cfs) | April-July Runoff Volume (Million A.F.)[2/] | Percent of Average April-July Runoff Volume |
| 09-Jun-27 | 106,000 | 9.539 | 123 |
| 26-May-28 | 104,000 | 9.049 | 117 |
| 14-May-32 | 114,000 | 9.544 | 123 |
| 10-Jun-33 | 128,000 | 9.386 | 121 |
| 15-May-36 | 101,000 | 8.473 | 109 |
| 19-Apr-38 | 123,000 | 7.477 | 97 |
| 09-May-47 | 108,000 | 8.105 | 105 |
| 29-May-48 | 166,000[1] | 11.923 | 154 |
| 16-May-49 | 117,000 | 9.488 | 122 |
| 21-May-56 | 112,000 | 10.254 | 132 |
| 20-May-57 | 123,000 | 8.937 | 115 |
| 09-Jun-64 | 117,000 | 10.029 | 129 |
| 21-Apr-65 | 109,000 | 9.371 | 121 |
| 13-May-71 | 100,000 | 10.448 | 135 |
| 02-Jun-72 | 123,700 | 11.795 | 152 |
| 16-Jun-74 | 132,000 | 12.188[3] | 157 |
| 11-May-76 | 104,600 | 10.116 | 131 |

[1] Maximum peak discharge 177,000 cfs, water years 1911-1913, 1926-1985.
[2] Average April-July runoff volume 7.814 million acre-feet based on water years 1911-1913, 1926-1985.
[3] Largest spring snowmelt runoff volume, water years 1911-1913, 1926-1985.

| TABLE 4-11<br><br>WINTER RAINSTORM AND SNOWMELT FLOODS<br>SUMMARY OF UNREGULATED DISCHARGE AND RUNOFF AT SPALDING | | | |
|---|---|---|---|
| Date | Maximum Mean Daily Discharge[1] (cfs) | Duration Above 80,000 cfs (Days) | Runoff Volume Above 80,000 cfs (A.F.) |
| 23 Dec 1933 | 157,000 | 3 | 206,600 |
| 23 Dec 1964 | 99,000 | 2 | 65,800 |

[1] Period of record water years 1911-1913, 1926-1985.

4-07 Runoff Characteristics.

a. General. Most of the annual runoff for the Clearwater River Basin originates within the upper watershed from a combination of winter rains and spring snowmelt floods. Principal runoff areas within the upper watershed are characterized by high precipitation headwater areas (50 to 60 inches normal annual precipitation), dense timber, sparse population, and very limited development.

b. Stream flow Records. Stream flow data records have been maintained at key gauging stations on the Clearwater River and major tributaries by the U.S. Geological Survey and published in the "USGS Water Resources Data for Idaho." In addition, unregulated stream flows for the North Fork above Dworshak Dam (2,440 square miles) and the Clearwater River at Spalding (9,570 square miles) have been computed by the Corps of Engineers, Walla Walla District, since construction of the project. Table 4-12 outlines key gauging stations and records within the Clearwater River Basin plus pertinent storage records for Dworshak Reservoir.

c. Upper Watershed Runoff. Natural stream flow from the upper watershed's two subbasins: (1) North Fork Clearwater River above Dworshak Dam, 2,440 square miles, and (2) Clearwater River above Orofino, 5,580 square miles, will have a significant impact on the regulation of Dworshak Reservoir. The stream flow pattern is generally low flows from late July through February, increasing flows during March, high flows during April through June, and receding flows during late June and July. During winter months, this general pattern is occasionally interrupted by high peak flows which are caused by rain snowmelt runoff events. These winter events are generally short in duration and limited in volume.

The following tabulation compares the average annual October to September water year runoff volumes for the two upper watershed subbasins with the total average annual runoff for the Clearwater River at Spalding:

| TABLE 4-12<br>KEY GAGING STATIONS - CLEARWATER RIVER BASIN | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | Yearly Mean Daily Discharge - cfs | | |
| Station | Data | Period of Record (water years) | Drainage Area Above Station (sq. mi.) | Average Volume (a.f./water year) | Average | Maximum | Minimum |
| North Fork Clearwater River near Canyon R.S. | Natural Flow | 1968 to 1985 | 1,360 | 2,636,400 | 3,600 | 30,800 (16 Jun 1974) | 250 (5 Dec 1972) |
| Dworshak Dam | Unregulated Inflow | 1927 to 1985 | 2,440 | 4,194,600 | 5,800 | 90,000 (23 Dec 1993) | 100 (20 Nov 1978) |
| Dworshak Dam | Regulated Outflow | 1973 to 1985 | 2,440 | 4,041,300 | 5,600 | 35,900 (18 Jun 1974) | 600 (15 Dec 1972) |
| Clearwater River at Orofino | Natural Flow | 1931 to 1938<br>1965 to 1985 | 5,580 | 6,510,800 | 9,000 | 87,300 (2 Jun 1972) | 250 (8 Jun 1937) |
| Clearwater River at Spalding | Unregulated Flow | 1911 to 1913<br>1926 to 1985 | 9,570 | 11,264,000 | 15,600 | 166,000 (29 May 1948) | 170 (10 Jan 1977) |
| | Regulated Flow | 1972 to 1985 | 9,570 | 11,441,800 | 15,800 | 124,000 (16 Jun 1974) | 1,390 (31 Oct 1971) |

Source: 1. USGS Water Resources Data - Idaho.
2. Corps of Engineers, Walla Walla District, Hydrology Branch

| Station | Drainage Area (Sq. Mi.) | Period of Record (Water Yr.) | Average Annual Oct-Sep Runoff Volume | |
|---|---|---|---|---|
| | | | (A.F.) | (Basin-Inches) |
| North Fork at Dworshak | 2,440 (25%) | 1927-1981 (37%) | 4,199,000 | 32.27 |
| Clearwater at Orofino | 5,580 (58%) | 1965-1980 (62%) | 6,970,000 | 23.42 |
| Clearwater at Spalding | 9,570 (100%) | 1926-1980 (100%) | 11,228,000 | 22.00 |

The preceding tabulation shows that about 99 % of the total runoff volume above Spalding originates from: (1) North Fork Clearwater River above Dworshak Dam and (2) Clearwater River above Orofino. The average annual runoff volume for the North Fork Clearwater above Dworshak represents about 11 % of the average annual runoff volume at Lower Granite, and the basin area above Dworshak represents about 2 % of the total drainage area above Lower Granite.

March to July spring runoff volumes also represent a significant portion of the annual October to September water year runoff volumes. The March to July runoff volume during the spring runoff season varies with seasonal snow accumulation, temperatures, and rainfall. The following tabulation shows the average percent contribution that the March to July runoff represents of the total October to September runoff volume for: (1) North Fork at Dworshak, (2) Clearwater at Orofino, and (3) Clearwater at Spalding:

| Station | Water Year Period of Record | Mar-Jul Runoff (Average Percent of Oct-Sep Runoff) |
|---|---|---|
| North Fork at Dworshak | 1927-1985 | 74 |
| Clearwater at Orofino | 1931-1938<br>1965-1985 | 80 |
| Clearwater at Spalding | 1911-1913<br>1926-1985 | 77 |

In addition, the March to July runoff volume from the North Fork on an average contributes about 35 % of the total March to July runoff volume for the Clearwater River at Spalding.

The North Fork Clearwater near Canyon Ranger Station is a key gauging station within the North Fork subbasin drainage area. This gauging station records stream flows for approximately 56 % of the 2,440 square miles of drainage area above Dworshak Dam. The station is located about 56 miles upstream of Dworshak Dam and is used to monitor a portion of the natural inflows into Dworshak Reservoir. Plate 4-2, Summary Hydrograph, summarizes natural stream flows since October 1967, and Table 4-13 lists monthly runoff volumes. Natural stream flows for the North Fork's total drainage area of 2,440 square miles have been computed since the Clearwater River at Ahsahka gauging station was discontinued in February 1965 because of Dworshak Dam construction. Plate 4-3, Summary Hydrograph, summarizes mean daily unregulated inflow at Dworshak Dam since October 1926, and Table 4-14 lists monthly runoff volumes. Plate 4-4 shows yearly hydrographs of mean daily unregulated inflows of the North Fork at Dworshak Dam for the period of record.

Stream flows from the 5,580 square miles of drainage area above Orofino are recorded at the gauging station, Clearwater River at Orofino. This station is located on the Clearwater River at RM 44.6 about 4 miles upstream from the confluence of North Fork and main stem Clearwater River. The flows for the Clearwater River at Orofino will have a significant effect on the releases from Dworshak during periods of extremely high flows. Plate 4-5, Summary Hydrograph, summarizes natural stream flows, and Table 4-15 lists monthly runoff volumes since October 1930.

Stream flows for the 9,570 square miles of drainage area above Spalding are recorded at the gauging station, Clearwater River at Spalding. Plate 4-6, Summary Hydrograph, summarizes unregulated discharge, and Table 4-16 lists monthly runoff volumes for the Clearwater River at Spalding.

d. Lower Watershed Runoff. The lower watershed consists of approximately 1,530 square miles of drainage area or about 16 % of the total basin area above Spalding. The natural March to July stream flow within the lower watershed represents about 5 % of less of the total March to July runoff from the entire Clearwater River Basin above Spalding. Occasionally, thunderstorm or heavy rain and rapid snowmelt floods can produce high peak flows of short duration. Runoff from these floods causes some local flooding and drainage problems for some areas within the lower watershed. However, peak discharges and runoff volumes from the lower watershed are considered to have little or no impact on the regulation of Dworshak Reservoir.

e. Droughts.

(1). North Fork at Dworshak. Low runoff volume years for the North Fork Clearwater River Basin can critically affect Dworshak's long-term capabilities for: (1) power generation used in meeting the total energy loads within the Northwest power system, (2) augmentation of low stream flow for fisheries in the lower Clearwater River and the lower Snake River, and (3) maintaining near full reservoir levels for summer recreation. The 1977 drought year had lowest October to September annual runoff volume of record, 1.856 million acre-feet, which is 44 % of average. The average October to September runoff volume is 4.2 million acre-feet for the 1927-1985 period of record. Table 4-17, summarizes low runoff and discharge data for the North Fork at Dworshak. Twelve years have had October to September runoff volumes less than 3.2 million acre-feet (75 % of average) since water year 1927.

(2). Clearwater River at Spalding. Table 4-18, summarizes low runoff and discharge data for the Clearwater River at Spalding during the 1926-1980 period of record. Twelve years have had October to September runoff volumes less than 8.4 million acre-feet (75 % of average) since 1926.

**TABLE 4-17**
**SUMMARY OF UNREGULATED LOW RUNOFF AND DISCHARGE DATA NORTH FORK CLEARWATER RIVER AT DWORSHAK DAMSITE**

| Water Year | October-September Annual Runoff Volume[1] (Million A.F.) | Percent Average October-September Runoff Volume | Annual Maximum Mean Daily Peak Discharge (cfs) |
|---|---|---|---|
| 1977 | 2 | 44 | 14,900 |
| 1944 | 2 | 51 | 13,600 |
| 1973 | 2 | 58 | 14,500 |
| 1941 | 2 | 58 | 11,200 |
| 1937 | 3 | 60 | 19,000 |
| 1929 | 3 | 62 | 22,100 |
| 1931 | 3 | 62 | 22,300 |
| 1930 | 3 | 65 | 19,600 |
| 1939 | 3 | 73 | 27,000 |
| 1940 | 3 | 73 | 16,400 |
| 1942 | 3 | 74 | 16,800 |
| 1966 | 3 | 75 | 22,800 |

[1] Average October-September annual runoff volume is 4.2 million acre-feet for water years 1927-1985 (59 years). Drainage area is 2,440 square miles.

**TABLE 4-18**
**SUMMARY OF UNREGULATED LOW RUNOFF AND DISCHARGE DATA CLEARWATER RIVER AT SPALDING**

| Year | October-September Annual Runoff Volume[1](Million A.F.) | Percent Average October-September Runoff Volume | Annual Maximum Mean Daily Peak Discharge (cfs) |
|---|---|---|---|
| 1977 | 5 | 47 | 42,100 |
| 1973 | 6 | 54 | 47,700 |
| 1944 | 6 | 55 | 48,400 |
| 1937 | 7 | 58 | 50,900 |
| 1941 | 7 | 58 | 37,400 |
| 1931 | 7 | 61 | 66,100 |
| 1930 | 7 | 66 | 51,000 |
| 1929 | 7 | 66 | 73,300 |
| 1926 | 8 | 68 | 59,700 |
| 1940 | 8 | 72 | 53,500 |
| 1966 | 8 | 72 | 63,600 |
| 1939 | 8 | 73 | 73,400 |

[1] Average October-September annual runoff volume is 11.290 million acre-feet for water years 1911-1913, 1926-1985 (63 years). Drainage area is 9,570 square miles.

4-08 Water Quality.

Post-impoundment conditions both within Dworshak Reservoir and downstream of Dworshak Dam in the main stem of the Clearwater River differ greatly from those in the free-flowing river, such as the Clearwater above Orofino. As a result of anticipated water quality changes, the U.S. Army Corps of Engineers contracted a reservoir limnological study to the University of Idaho in March 1972 (Contract DACW68-72-C-0142). The final report entitled, "Early Limnology of Dworshak Reservoir," was submitted to the Corps of Engineers in 1979 by the University of Idaho. In addition, water quality parameters are monitored at five reservoir stations and one station downstream of Dworshak Dam by District personnel. The chemical quality of Dworshak releases is also monitored by the Dworshak hatchery personnel. The Idaho Fish and Game Department takes periodic samples of the chemical quality in the lower Clearwater.

The following paragraphs discuss the water quality for Dworshak Reservoir and the lower Clearwater River.

a. Dworshak Reservoir. No permanent or serious water quality problems have been observed in Dworshak Reservoir since it was completely filled in 1973. With the low watershed nutrient contributions and lack of point sources, Dworshak Reservoir is approaching trophic equilibrium as a cold nutrient-poor lake with high aesthetic water quality. Profiles of water temperature, dissolved oxygen, specific conductance, turbidity, pH, and alkalinity, and samples for selected chemical, physical, and biological parameters are collected at the five reservoir stations and one station just downstream of Dworshak Dam. Inflow temperatures are recorded at North Fork Clearwater River near Canyon ranger station stream flow gage, and Dworshak release temperatures are recorded at the Dworshak National Fish Hatchery. Water temperatures from thermistors placed in the face of the dam are recorded at the dam.

The following paragraphs discuss in general terms pertinent water quality indicators for Dworshak Reservoir.

(1). Water Temperature. Thermally, the 53-mile reservoir may be considered two separate reservoirs. The deeper, lower 20 miles are monomictic, and the middle and upper reaches are dimictic. Thermal stratification, or temperature layering, of the reservoir generally begins in late April, and by mid-May a distinct thermocline has developed and remains into November. Depth to the thermocline increases as the summer progresses from about 15 feet in May to July, about 20 to 25 feet in August, and about 25 to 30 feet in September. During July and August, the average temperature of the spilimnion has ranged from 70 degrees to 75 degrees Fahrenheit. The reservoir's cooling trend, as noted in the post-impoundment study ("Early Limnology of Dworshak Reservoir," 1979) has apparently stabilized. The mean reservoir temperature during mid-August (the time of maximum heat content) varies from 45 degrees to 49 degrees Fahrenheit. Waters deeper than 100 feet generally remain below 45 degrees the year around. Plate 4-7 shows typical reservoir water temperature profiles versus depth and time of year.

b. Dissolved Oxygen. Depth, distance upstream, and season of the year are variables affecting dissolved oxygen levels in the reservoir. In the vicinity of the dam, spring deep water dissolved oxygen concentrations are dependent upon the amount of reservoir mixing that can occur before stratification. The longer the circulation interval, the greater the resupply of oxygen to deep waters. During April, surface water dissolved oxygen levels range from 100- to 110- % saturation at all stations. At the deepest station, River Mile (RM) 3, dissolved oxygen levels at 600 feet ranged from 65- to 70 % saturation. Late summer deep water dissolved oxygen levels varied from 35- to 45 % saturation.

(1). <u>Turbidity</u>. Four high turbidity patterns may be observed annually in Dworshak's epilimnial waters, but any 1 year might not have all four, which include:

(a). A peak of inorganic solids attributed to high runoff in early spring.

(b). The spring diatom bloom.

(c). The midsummer phytoplankton bloom.

(d). The fall phytoplankton bloom.

The trend through Dworshak Reservoir is generally high turbidity with minimum secchi disc readings occurring in the summer-fall period. Table 4-19 summarizes maximum and minimum secchi disc readings for five water quality stations: (1) North Fork Clearwater RM 3, (2) North Fork Clearwater RM 19, (3) North Fork Clearwater RM 35, (4) Elk Creek Mile 4, and (5) Little North Fork Clearwater RM 1.

(2). <u>Specific Conductance</u>. Conductivity, a measure of ions in solution, is a convenient index of gross water quality trends over a period of time. Deep water conductivity measurements have been relatively stable since 1976, and values range from 31 to 39 μmhos/cm at RM 3. In April, surface values generally increase with distance downstream from 31 to 35 μmhos/cm at RM 35 to 33 to 40 μmhos/cm at RM 3. During summer stratification, little horizontal variation in conductivity is noted. The average epilimnion specific conductance in July-August ranged from 33 to 36 μmhos/cm. These small fluctuations in conductivity serve to confirm the nutrient-poor status of Dworshak Reservoir.

c. <u>Lower Clearwater River</u>. Heating and cooling requirements of water used by the Dworshak National Fish Hatchery dictate Dworshak discharge temperatures. The selective withdrawal system for Dworshak is used to provide suitable water temperatures. The thermal structure existing in the reservoir during stratification has resulted in modification of water temperatures in the North Fork below the dam and the lower Clearwater River from the hatchery downstream to Lewiston. Table 4-20 shows average monthly river temperatures for: (1) Clearwater River near Orofino (RM 41.0), (2) North Fork Clearwater River at Dworshak Dam, and (3) Clearwater River near Peck (RM 37.4).

During the summer-fall reservoir stratification period from June-November, river temperatures vary from 40 degrees to 70 degrees Fahrenheit for the Clearwater River near Orofino, from 45 degrees to 55 degrees Fahrenheit for the North Fork Clearwater River at Dworshak Dam and from 45 degrees to 60 degrees Fahrenheit for the Clearwater River near Peck is a minus 5 degrees to 10 degrees Fahrenheit cooler from June-September and a plus 0 degrees to 5 degrees Fahrenheit warmer from October-November as a result of discharges from Dworshak Dam. December-May Dworshak discharge temperatures in the range of 40 degrees to 45 degrees Fahrenheit have eliminated the problem of ice jams in the lower Clearwater River.

The chemical quality of Dworshak releases is monitored at the hatchery. The Idaho Fish and Game Department takes periodic samples of chemical quality in the lower Clearwater River. There have been no significant adverse results reported to date.

During periods of spill from Dworshak Dam, the total concentration of dissolved gas downstream of Dworshak Dam has occurred at levels in excess of the State of Idaho's 110 % water quality standard for waters designated for salmonid spawning. From 1976 to 1985, the percent saturation range varied from a minimum of 96.8 % to a maximum of 127.6 %. However, periods of spills have been infrequent, and no adverse effects on the ecosystem have been observed. Table 4-21 shows 1976 to 1985 maximum and minimum dissolved gas readings collected from the North Fork Clearwater River at the Dworshak Hatchery. Table 4-22 summarizes Dworshak Dam daily spill for the period 1972 to 1985.

**TABLE 4-21**
**SUMMARY OF NITROGEN GAS ($N_2$) READINGS**
**NORTH FORK CLEARWATER RIVER AT DWORSHAK FISH HATCHERY (1976-1985)**

| Period | Maximum $N_2$ (%) | Minimum | Average |
|---|---|---|---|
| 31 Mar-15 Sep 1977 | 124 (8 Apr) | 101.1 (27 Jun) | 109.4 |
| 4 Apr-2 Nov 1977 | 123.5 (1 Aug) | 99.9 (31 May) | 108.5 |
| 24 Feb-12 Jul 1978 | 110.3 (27 Apr) | 100.0 (24 Feb) | 105.1 |
| 23 Feb-20 Jul 1979 | 112.3 (16 Jun) | 101.7 (20 Jul) | 106.1 |
| 20 May-16 Dec 1980) | 122.9 (21 Oct) | 99.2 (25 Nov) | 106.3 |
| 2 Jan-8 Dec 1981 | 127.6 (19 Jan) | 98.7 (16 Nov) | 104.9 |
| 3 Apr-20 Dec 1982 | 123.7 (19 Jul) | 98.2 (22 Nov) | 108.4 |
| 10 Jan-13 Dec 1983 | 116.8 (8 Aug) | 105.4 (18 Jan) | 99.2 |
| 3 Jan-5 Dec 1984 | 115.9 (13 Jun) | 96.8 (5 Dec) | 105.1 |
| 22 Jan-7 Jul 1985 | 109.3 (22 Apr) | 97.1 (22 Jan) | 104.6 |

A reconnaissance report completed in April 1978 indicated that the addition of a fourth unit is economically feasible. Studies assessing the fourth unit's impact on water quality indicate no adverse effects would develop.

During the low flow years, the potential exists to use Dworshak releases to improve potential water quality problems in the lower Snake River reservoirs. Consideration was given to such a plan in the 1977 low flow year, but the anticipated water quality problems did not develop.

4-09 Channel and Floodway Characteristics.

The regulation of flow at Dworshak Dam affects stream flow conditions in the lower Clearwater River. The following paragraphs discuss channel characteristics, key control points, and water travel times for the lower Clearwater River.

a. Channel Characteristics. The lower Clearwater River channel generally flows in a westerly direction from the North Fork and main stem confluence near Ahsahka downstream to the Clearwater and Snake River confluence at Lewiston. The channel has a well defined path that cuts deep below the area's plateau lands. The riverbanks slope at steep angles which are generally formed by adjoining bluffs and hills. Exceptions to this occur in areas where gently sloping lands lie adjacent to the river, mainly at the following locations:

1. South side, mile 8 to 9.
2. North side, mile 9.5 to 11.
3. South side, north Lapwai to mile 12.5.
4. South side at Myrtle.
5. South side, mile 20 to 22.
6. North side, mile 22 to 23.5.
7. South side, mile 27.5 to 28.5.
8. South side, mile 34 to 35.5.
9. South side, mile 39.5 to 40.5.

The lower Clearwater River is generally well served by railroads, highways, and secondary roads from Lewiston upstream to Orofino. Six roadway bridges and two railroad bridges cross this reach at the following localities:

1. Burlington Northern Railroad Bridge, RM 0.6.
2. Clearwater River Memorial Bridge, RM 2.0.
3. Interstate Highway 95 Bridge, RM 10.6.
4. Camas Prairie Railroad Bridge, RM 12.4.
5. Interstate Highway 12 Bridge, RM 14.9.
6. Cherry Lane Bridge, RM 21.1.
7. Lenore Bridge, RM 28.8.
8. Orofino Bridge, RM 44.6.

The lower Clearwater River between Orofino and Lewiston has an average width of about 600 feet, a minimum width of about 300 feet, and a maximum width of about 1,100 feet.

The average slope of the lower Clearwater River is approximately 6 to 7 feet per mile. The following tabulation summarizes estimated average velocities for significant flows at the Orofino and Spalding stream gages.

| | | Bankfull | | Flood Stage | |
|---|---|---|---|---|---|
| **Clearwater River Gage** | **Drainage Area (Sq. Mi.)** | **Discharge (cfs)** | **Average Velocity (fps)** | **Discharge (cfs)** | **Average Velocity (fps)** |
| At Orofino | 5,580 | 67,000 | 10 | 75,000 | 11 |
| At Spalding | 9,570 | 115,000 | 11 | 115,000 | 11 |

NOTE: Data received from National Weather Service and U.S. Geological Survey, Boise, Idaho.

b. Key Control Points. Two principal control points restrict and govern the manner in which Dworshak Reservoir can be regulated for power and flood control requirements. The first control point downstream of Dworshak is the Clearwater near Peck gauging station, which is located about 5 miles downstream from Dworshak Dam (RM 37.4). The restriction at the Peck gauging station is that the maximum allowable rate of change in water surface elevation during normal project operations is 1 foot per hour in order to protect downstream activities. The second control point is the Clearwater River at Spalding gauging station, which is located at RM 11.6. This gauging station is the principal control point for flood control regulation of the Clearwater River by Dworshak Reservoir. Dworshak's regulation objective is to limit floodflows at the Spalding gage to 150,000 cfs or less in order to provide standard project flood protection for Lewiston, Idaho.

c. Travel Times. The following tabulation shows approximate travel times to key downstream locations when: (1) Dworshak Dam discharge is increased from 2,200 cfs (1 unit) to 10,000 cfs (full power plant capability), and (2) the flow in the Clearwater River at Orofino is in the range of 5,000 cfs to 5,500 cfs.

| **Location** | **Flow (cfs)** | **Approximate Travel Time from Dworshak (Hours)** |
|---|---|---|
| Clearwater River near Peck (RM 37.4) | 16,000 | 1 |
| Clearwater River at Spalding (RM 11.6) | 16,000 | 6 |
| Clearwater River at East Lewiston Gage (RM 2.9) | 16,000 | 8.5 |

NOTE: Travel times shown above are based on 19-21 December 1981 hourly data.

4-10 Upstream Structures.

There are no upstream structures.

4-11 Downstream Structures.

Downstream structures include the four Lower Snake River dams operated by the USACE.

4-12 Economic Data.

a. Population. The population data presented in the following tabulation shows a population growth within the five counties from 82,896 in 1970 to 91,090 in 1980, which is about a 10 % increase over the 10-year period. The two major cities within the region, Moscow and Lewiston, showed 16 % and 6 % increases, respectively, in population during the 1970 to 1980 period.

| POPULATION OF CLEARWATER REGION | | | | | |
|---|---|---|---|---|---|
| **County** | **Clearwater** | **Idaho** | **Latah** | **Lewis** | **Nez Perce** |
| 1950 | 8,217 | 11,423 | 20,971 | 4,208 | 22,658 |
| 1960 | 8,548 | 13,542 | 21,170 | 4,423 | 27,066 |
| 1970 | 10,871 | 12,891 | 24,891 | 3,867 | 30,376 |
| 1980 | 10,390 | 14,769 | 28,749 | 4,118 | 33,220 |

| Major City | Orofino | Grangeville | Moscow | Kamiah | Lewiston [1] |
|---|---|---|---|---|---|
| 1950 | 1,656 | 2,544 | 10,593 | 812 | 16,928 |
| 1960 | 2,471 | 3,642 | 11,183 | 1,245 | 22,696 |
| 1970 | 3,883 | 3,636 | 14,146 | 1,307 | 26,068 |
| 1980 | 3,711 | 3,666 | 16,531 | 1,478 | 27,986 |

[1] Includes Lewiston and Lewiston Orchards

NOTE: Data obtained from Bureau of Census reports 1950-1980.

b. Agriculture and Industry. Timber and agriculture are the major economic resources within the five counties around the Dworshak Project. These counties are Clearwater, Idaho, Latah, Lewis, and Nez Perce, and they have a total area of 8.6 million acres. The following tabulation outlines the land use distribution within these five counties.

| LAND USE IN CLEARWATER REGION | | |
|---|---|---|
| **Land Use** | **Area (Million Acres)** | **Total Area (Percent)** |
| Forest | 4.90 | 57 |
| Agriculture | 2.06 | 24 |
| Baren | 1.55 | 18 |
| Urban and Industrial | 0.09 | 1 |
| Totals | 8.60 | 100 |

c. Flood Damages. The lower Clearwater River reach from the former Washington Water Power damsite to the mouth, including the Potlatch Forests, Inc., paper and plywood mill and the city of Lewiston, Idaho, is considered to be fully protected from flooding to the extent which is economically feasible by a combination of Dworshak regulation and levees. The Lewiston levees are designed to protect the area from flooding with flows up to 150,000 cfs. The winter standard project flood at Spalding has a natural peak of 280,000 cfs and can be regulated to 150,000 cfs by Dworshak. Flood damage in the reach from Dworshak to Lewiston consists of erosion of highways, railroads, levees, and bridge abutments, with some flooding of low-lying rural residential and agricultural properties in the lower Clearwater River. At frequent high flows, less than 100,000 cfs at Spalding, U.S. Highway 12, and the Camas Prairie generally receive no damage at areas exposed to erosion by the Clearwater River because large amounts of riprap have been placed in these areas. Flood damages above the Lower Granite levees on the lower Clearwater River begin at about 90,000 cfs and increase significantly for flows at Spalding in excess of 105,000 cfs. Bankfull capacity is 115,000 cfs for the Clearwater River at Spalding. The tabulation on the following page summarizes flood damages in the lower Clearwater River based on October 1981 price and development level.

Information on areas subject to flooding in the lower Clearwater River from Orofino to Lewiston can be found in existing floodplain information reports. The following list summarizes some reports which are available.

(1). Floodplain Information, Orofino and Riverside, Idaho, Clearwater River, U.S. Army Corps of Engineers, Walla Walla, Washington, May 1968.

(2). Floodplain Information, Orofino-Whiskey Creek, Orofino, Idaho, and Vicinity, U.S. Army Corps of Engineers, Walla Walla, Washington, October 1972.

(3). Flood Insurance Study, City of Lewiston, Idaho, Clearwater River and Snake River, Federal Emergency Management Agency, Federal Insurance Agency, Community Number 160104, January 1981 (Preliminary).

| CLEARWATER RIVER, IDAHO<br>Flow Versus Damage Relationship Mouth of North Fork, Including Town of Ahsahka to Confluence with Snake River at Lewiston, Idaho<br>1 October 1981 Price Level and Development | | | |
|---|---|---|---|
| **Flood flow Spalding Gage** | **Mouth of North Fork to Lower Granite Levee Reach – Flood Damage ($)** | **Lower Granite Levee Reach (Lewiston, ID) Flood Damage ($)** | **Total North Fork to Confluence - Flood Damage[1] ($)** |
| 80,000 | 0 | 0 | 0 |
| 100,000 | 9,300 | 0 | 9,300 |
| 105,000 | 27,800 | 0 | 27,800 |
| 125,000 | 222,600 | 0 | 222,600 |
| 150,000 | 1,159,000 | 0 | 1,159,300 |
| 165000 | 2,086,700 | 4,783,900 | 6,870,600 |
| 177,000 (1948) | 2,782,200 | 7,889,100 | 10,671,300 |
| 190,000 | 3,616,900 | 22,614,800 | 26,231,700 |
| 200,000 | 4,303,100 | 33,922,200 | 38,225,300 |
| 210,000 | 4,970,800 | 45,664,500 | 50,635,300 |
| 220,000 | 5,657,100 | 57,406,800 | 63,063,900 |
| 230,000 | 6,399,100 | 69,149,100 | 75,548,000 |
| 240,000 | 7,141,000 | 80,891,400 | 85,032,400 |
| 250,000 | 7,901,400 | 93,068,600 | 100,970,000 |
| 260,000 (SPF) | 8,717,600 | 115,683,400 | 124,401,000 |

[1] Lower Granite levees effective to 150,000-cfs flow.

# 5 DATA COLLECTION AND COMMUNICATION NETWORKS

5-01 Hydrometeorological Stations.

a. Facilities

(1). Automated Hydromet Systems.

(a). Bureau Hydromet System. The Pacific Northwest Regional Office of the Bureau of Reclamation has an extensive automated hydrometeorological data collection system throughout the upper, middle, and lower Snake River basins. This system is composed of (1) a Direct Readout Ground Station (DRGS) located in Boise for the Geostationary Operational Environmental Satellite (GOES), (2) a computerized network controller, referred to as the Central Computer Facility (CCF), and (3) remote stations.

The system is unique in that the Data Collection Platform (DCP) at each remote site is microprocessor-controlled and has the capability to transmit through two channels on the GOES system. One channel handles only self-timed transmissions, whereas the second channel is dedicated to only adaptive random transmissions. Operation in the self-timed mode is as follows. The DCP interrogates all sensor outputs at 15-minute intervals and stores the values in its memory. At a preassigned time interval, every 4 hours, the DCP transmits all stored values from each sensor to the Central Computer Facility through the Direct Readout Ground Station in Boise. This produces a very complete detailed data base.

Transmissions in the adaptive random reporting (R/R) mode are completely unscheduled with the decision to transmit being made by the DCP. This is accomplished by programming threshold values in the microprocessor which the DCP uses to compare with sensor output. If the threshold values are exceeded, the DCP computes a random transmission rate and begins to transmit randomly. The microprocessor also computes rates of change between sensor readings; if the rate of change exceeds the preprogrammed threshold values, this also causes the DCP to compute a random transmission rate and begin transmitting. Each time a DCP transmits randomly, it only sends three values - the most current value and the two preceding values. Also, once the DCP goes into random mode, it will send at least three transmissions randomly before shutting down. However, if the threshold values are continually exceeded and/or the rates of change increase, the DCP will continue in the random mode until the situation returns to normal. It is important to note that as the rate of change of the sensor value increases, the random transmission interval is shortened, thereby transmitting more frequently as the event becomes more serious.

All data received by the Central Computer Facility (CCF) are immediately processed and stored in the Dayfiles. At 5:00 a.m. each morning, the CCF compiles data from the previous day's Dayfiles database file readings to be put into the Archives database. The Archives database is composed of such things as midnight reservoir elevation and contents, maximum and minimum temperatures, and mean daily flows, etc. Both Dayfiles and Archives databases are available to users through terminals.

(b). CROHMS (Corps of Engineers).

1. General. The Columbia River Operational Hydromet and Management System (CROHMS) is a real-time water resources data management system. A computer system is used for data reduction, system modeling, forecasting, and data base support functions. The data acquisition for these functions is supported through the CROHMS Automated Front End (CAFE). Figure 5-2 on page 5-8 shows the CROHMS network diagram. Details on the CROHMS data collection system are contained in the Columbia River Basin, Master Water Control Manual, December 1984.

In addition, the Columbia Basin Telecommunications (CBT) network, operated by the Corps of Engineers, is now merged with CROHMS. The CROHMS CAFE computer performs the polling functions for the CBT circuit.

2. Use of CROHMS Data. The real-time data are used for the operational management and forecasting of the Columbia River system. The output system is designed to be flexible and easy to use in carrying out the water management responsibilities on a day-to-day basis or for special operating conditions, for maintaining surveillance of the river and reservoir system, and for developing forecasts or operating plans for future regulation.

(2). Streamflow and Reservoir Data. Daily streamflow and reservoir data is essential for optimum regulation of the Dworshak Project. All major rivers and reservoirs are gauged, and daily reports are usually available when required through the U.S. Bureau of Reclamation's VAX system and the Corps of Engineers-CROHMS system.

The following tabulation summarizes real-time data which are available from the Bureau's hydromet system:

| | Parameters | |
|---|---|---|
| **Station Archives** | **Dayfiles** | **Stream Gages** |
| 1. North Fork Clearwater River at Canyon Ranger Station (CRSI) | GD,HJ,QD | GH,HJ,Q |
| **Dam and Reservoir** | | |
| 1. Dworshak Dam (DWR) | AF,FB,ID,QD[2] | |
| **Stream Gages** | | |
| 1. Lochsa River near Lowell (LOCI) | GD,HJ,QD | GH,HJ,Q |
| 2. Selway River near Lowell (SELI) | GD,HJ,QD | GH,HJ,Q |
| 3. South Fork Clearwater River at Stites (STII) | GD,HJ,QD | GH,HJ,Q |
| 4. Clearwater River at Orofino (ORFI) | GD,HJ,QD | GH,HJ,Q |
| 5. Clearwater River at Peck (PEKI) | GD,HJ,QD | GH,HJ,Q |
| 6. Clearwater River at Spalding (SPDI) | GD,HJ,QD | GH,HJ,Q |

[2] Not real time data. Transferred from CROHMS.

AF - Midnight Content (KAF)
FB - Midnight Forebay Elevation
GD - Mean daily gage height
GH - Observed gage height
HJ - Gage height rating shift
ID - Computed Mean Daily Inflow
QD - Mean Daily Discharge

The following data is available from the Corps of Engineers CROHMS database:

| Station | Parameters |
|---|---|
| 1. North Fork Clearwater River at Canyon Ranger Station (CRSI) | HGIRGZZA, QRIRGZZA, QRDPAZZ |
| 2. Dworshak Dam (DWR) | HFDRXZZA, HFIRXZZA, LSIRXZZA, QIDRXZZA, QRHRXZZA, QRDPAZZ |
| 3. Lochsa River near Lowell (LOCI) | HGIRGZZA, QRIRGZZA, QRDPAZZ |
| 4. Selway River near Lowell (SELI) | HGIRGZZA, QRIRGZZA, QRDPAZZ |
| 5. South Fork Clearwater River at Stites (STII) | HGIRGZZA, QRIRGZZA, QRDPAZZ |
| 6. Clearwater River at Orofino (ORFI) | HGIRGZZA, QRIRGZZA, GRDPAZZ |
| 7. Clearwater River at Peck (PEKI) | HGIRPZZA, QRIRPZZA, QDRPAZZ |
| 8. Clearwater River at Spalding (SPDI) | HGIRGZZA, QRIRGZZA, QRDPAZZ |

HFDRXZZA - Daily Mean Forebay Elevation
HFIRXZZA - Hourly Forebay Elevation
HGIRGZZA - Gage Height via GOES Satellite
HGIRPZZA - Gage Height via Phone or Radio
HGIRXZZA - Gage Height via Phone or Radio
LSIRXZZA - Reservoir Content (acre-feet)
QIDRXZZA - Computed Inflow Sent from Project
QRDPAZZ - Computed Mean Daily Release
QIDRXZZA - Computed Mean Daily Flow
QRIRGZZA - Hourly Flow from Satellite Stage

(3). SCS Snotel System. The Soil Conservation Service owns and operates a hydromet system for the Snake River Basin as part of its western states Snow Telemetry (SNOTEL) program. This system uses (1) two master polling stations located at Boise, Idaho, and Ogden, Utah, (2) meteor burst radio communications, and (3) remote stations. The system collects remote data once per day during a nominal polling period (5:00 a.m. to 8:00 a.m. Pacific time) and has capability of additional interrogations (ad hoc polls) as needed. A total of up to six parameters may be retrieved from each remote data site, with ultimate plans for retrieving a total of 16 parameters. The six parameters include:

1. Snow water content as measured by snow pillow (SP)
2. Cumulative precipitation (PC)
3. Air temperature (OB)
4. Maximum air temperature (TMAX)
5. Minimum air temperature (TMIN)
6. Average air temperature (TAVG)

Real-time SNOTEL data is retrieved automatically from the SCS-Data General computer system's data base in Portland, Oregon, into the Corps CROHMS system on a daily basis. Users also have direct access to SNOTEL data through the SCS Data General system.

b. Reporting

(1). Purpose. To fully regulate winter and spring floods and assure sufficient storage of water for power and recreation, a timely exchange of basic data between Dworshak Project, Walla Walla District, and North Pacific Division is required. A list of key officials and telephone numbers is included on page vii (pink sheets) of this Manual for both normal regulation and abnormal events. During abnormal events, the exchange of data will be expedited by telephone to these officials during non-duty hours. On occasions of an emergency nature, the normal communication channels may be out of service, and emergency action may have to be used. Emergency actions to be taken are summarized on page viii (pink sheets) of this Manual.

(2). Frequency of Exchange. The frequency of exchange of basic data pertinent to efficient operation of the dam and regulation of floods will be on a daily basis during the work week except during unusual or rare conditions of weather or reservoir inflow when the frequency will be as requested or needed. Data is automatically sent to the Corps of Engineers CROHMS system on an hourly basis 7 days per week from the Bureau of Reclamation Hydromet System located in Boise.

(3). Use of Real-Time Data. Real-time data are used for volume forecasting and in the Streamflow Synthesis and Reservoir Regulation (SSARR) Model. Volume forecast and SSARR Model results from the basis for reservoir regulation decisions and resultant reservoir regulation. Also, the output from CROHMS and SNOTEL systems is designed to be flexible and easy to use in carrying out the water management responsibilities on a day-to-day basis or for special operating conditions, for maintaining surveillance of the river and reservoir system, and for developing forecasts or operating plans for future regulation.

c. Maintenance

5-02 Water Quality Stations.

a. Facilities

Profiles of water temperature, turbidity, pH, and alkalinity and samples for selected chemical, physical, and biological parameters are collected at five points on Dworshak Reservoir and one point just downstream of Dworshak Dam. The following tabulation lists these sample sites in downstream order:

a. Little North at river mile 1
b. North Fork Clearwater at river mile 35
c. North Fork Clearwater at river mile 19
d. Elk Creek at river mile 4
e. North Fork Clearwater at river mile 3
f. North Fork Clearwater at river mile 0.5 (downstream of dam)

Data from these five reservoir stations are collected by the Walla Walla District Environmental Resources Branch. Twenty-one forebay thermohms located along the upstream face of Dworshak Dam provide water temperature profile data needed for adjusting project discharge temperature. Also, one telephone accessible thermohm, located on Unit 1's nose pier in the powerhouse tailrace, provides turbine discharge temperature data. Project personnel record thermohm data daily. River temperature data are readily available from the following automated stations:

a. North Fork Clearwater River near Canyon Ranger Station, river mile 58.0
b. North Fork Clearwater River at Dworshak Fish Hatchery, river mile 0.3
c. Clearwater River at Orofino, river mile 44.6
d. Clearwater River at Peck, river mile 37.4

These four stations transmit data to the Walla Walla District Corps of Engineers base station and North Pacific Division Corps of Engineers CROHMS data base computer.

b. Reporting.

The Walla Walla District Environmental Resources Branch is responsible for the collection of water quality data and publishes reports on water quality activities and problems.

Results of post-impoundment studies for water quality conditions both within Dworshak Reservoir and the lower Clearwater River channel have been discussed previously in paragraph 4-08 Water Quality.. Plate 4-1 also shows the locations of key water quality stations.

c. Maintenance.

5-03 Sediment Stations.

a. Facilities

There are no sediment stations.

b. Reporting

c. Maintenance

5-04 Recording Hydrologic Data.

The Geological Survey collects streamflow data and annually publishes recorded data in their publication, “Water Resources Data for Idaho.” The Soil Conservation Service collects manual snow course measurement data and publishes the data in their monthly publication, “Water Supply Outlook for Idaho.” In addition, SNOTEL stations provide real-time snow water content data on a daily basis via the SCS’s Data General System. The National Weather Service collects climatic data and publishes it annually in their Climatological Data for Idaho publication.

For real-time reservoir regulation, data are readily available, once collected, from the Bureau of Reclamation VAX Computer and the Corps of Engineers CROHMS system which provide real-time data as listed in paragraph 5-01a(1)(b). Figure 5-1 shows a schematic for the Clearwater Basin hydromet system.

5-05 Communication Network.

5-06 Communication with Project.

a. Between North Pacific Division (NPD) and Dworshak. The North Pacific Division Reservoir Control Center (RCC) is responsible for the daily reservoir regulation of the Dworshak Project. The Columbia Basin Telecommunications network (CBT) is the primary communication tool used by RCC to issue normal day-to-day instructions and schedules to the project. In addition, RCC can also telephone the project via the Federal telecommunications system (FTS) or the commercial telephone system.

A large amount of river, reservoir, weather, and related operating data is transmitted via the Columbia Basin Teletype Circuit. The circuit connects the North Pacific Division and the Walla Walla, Portland, and Seattle District Offices with all major projects on the main stem Columbia River. The circuit also includes Bonneville Power Administration, Portland, Oregon; British Columbia Hydro Office, Vancouver, British Columbia; Bureau of Reclamation and Weather Bureau Offices, Boise, Idaho; and the Geological Survey Northwest Regional Water Data Center in Portland, Oregon.

For emergency situations, refer to the pink sheets, pages vi-vii, in front of this Manual. Also, in the event of normal telephone and CBT systems outage, communication between the project will be established via the Walla Walla District radio system.

b. Between Walla Walla District (NPW) and Others. Direct communication between the District and Dworshak Dam is normally by telephone via a Bonneville Power Administration (BPA) microwave link through McNary Dam. The Federal Telecommunications System (FTS) is used between NPW and NPD, and via this system, most other long-distance calling can be handled.

A microwave radio and microwave telephone system connects all District projects except Lucky Peak. McNary Dam is the control center for this system. Radio communication to commercial floating craft and the U.S. Coast Guard utilizes assigned marine frequencies 156.7 megacycles for contacting and emergencies, and 156.80 megacycles for working traffic. Radio communication between mobile and portable units and the District Office or a project control room is on the Corps' operating frequency 163.4125 megacycles. Relay stations at various locations increase mobile radio coverage. Microwave radio channels link the project control rooms and the District office.

When the operator at Dworshak leaves the control room, McNary can switch the microwave radio system and rebroadcast over the mobile or portable frequency, 163.4125 MC, and reach the operator anywhere on the project.

A microwave telephone system provides an additional link between the District Office and the projects. With the microwave radio and telephone system available, it is possible to communicate between a mobile radio and any project or District telephone extension via McNary control room.

5-07 Project Reporting Instructions.

5-08 Warnings.

# 6 HYDROLOGIC FORECASTS

6-01 General.

The development of reservoir regulation plans for the Dworshak Project during flood control and refill operation is based primarily on seasonal runoff volume forecasts and daily stream flow forecasts.

a. Role of the Corps. The NPD Corps of Engineers RCC is directly responsible for coordination of operational planning and regulation of Corps of Engineers reservoirs. The Hydrology Branch is responsible for preparing seasonal runoff forecasts for the North Fork Clearwater River Basin above Dworshak Dam.

b. The Portland River Forecast Center of the NWS is responsible for issuing coordinated water supply forecasts for the Columbia River Basin system based on forecasts from B.C. Hydro, BPA, Bureau of Reclamation, Corps of Engineers, SCS, and the RFC. RFC also makes peak discharge estimates for key gauging stations in the Columbia River Basin based on 1 April runoff volume forecasts. These peak flow forecasts are based on statistical relationships between peak flow and runoff volume.

For real-time, short-range daily regulation, the RCC uses the SSARR computer program. This program is a mathematical hydrologic model incorporating routing procedures, snowmelt, and precipitation data to simulate stream flows. The storage effects of natural lakes and regulated reservoirs can also be evaluated with stream flow conditions and specified reservoir regulation conditions. The SSARR model is very valuable during the April-July spring refill season for planning and evaluating reservoir regulation plans for Dworshak. RFC and RCC develop SSARR forecasts cooperatively and use results to carry out their public service and operational responsibilities. Refer to the Master Water Control Manual dated December 1984 for more information on use of the SSARR model on day-to-day flood control analysis and power scheduling analysis.

6-02 Flood Condition Forecasts.

6-03 Conservation Purpose Forecasts.

See Section 06-05.

6-04 Long Range Forecasts.

6-05 Drought Forecasts.

During drought years, the SSARR model has provided data necessary for regulation. Volume forecast procedures based on regression analysis for low flow or drought years will be developed by the Walla Walla District as sufficient data and time become available.

6-06 Seasonal Runoff Volume Forecasts.

a. The NPW Hydrology Branch is responsible for developing the seasonal runoff volume forecast procedures for Dworshak unregulated inflows. The NPD RCC normally uses NPW's forecast for Dworshak's long-range operational forecast. However, the NPD RCC reviews all water supply forecasts received by the Portland RFC before finalizing the operational forecast for Dworshak. These operational forecasts are essential for developing and adjusting Dworshak's seasonal reservoir regulation plans. Runoff volume forecasts are normally made about 1 January and revised on a bimonthly basis through 1 June as hydrometeorological data becomes available (near the beginning and middle of each month).

b. NPW's runoff volume forecast procedure was developed by regression and correlation techniques, which use snow water content data and precipitation data as the primary independent variables. The District's forecast procedure is presented in Exhibit 6-1 of this manual.

c. SSARR Forecasts. Operational forecasts for short-term daily regulation are made cooperatively by the NPD RCC and the Portland RFC. The SSARR model is comprised of three basic components:

(1). A generalized watershed model for synthesizing runoff from snowmelt, rainfall, or a combination of the two as drainage basin outflows.

(2). A river system model for routing stream flows from upstream points to downstream points through channel and lake storage. Stream flows may be routed as a function of multivariable relationships involving backwater effects from tides or reservoirs.

(3). A reservoir regulation model whereby reservoir outflow and contents may be analyzed in accordance with predetermined or synthesized inflow and free flow or any of several modes of operation.

SSARR forecasts normally begin about 1 April and continue until the flood potential becomes minimal, which is usually sometime in July. During the early part of the spring flood season, the frequency of these forecasts is 3 days per week on Monday, Wednesday, and Friday. The Monday and Friday forecasts are short-range forecasts for 10 days in advance. The Wednesday forecast is a long-range forecast which covers the period from the initial forecast date through July.

During the peak flow and recession flow period, long-term extended forecasts are made every day. These extended forecasts continue until the danger of flooding is past and the reservoirs are filled. Since weather forecasts are usually reliable only for 3 to 5 days in advance, the hydrometeorological factors affecting runoff must be extended during the forecast period on the basis of average and extreme snowmelt conditions in order to compare probable flows with the most severe flows likely to occur.

# 7 WATER CONTROL PLAN

7-01 General Objectives.

The general purpose of this Water Control Plan is to define reservoir regulation procedures and practices which provide maximum benefits from authorized uses when the project is regulated as a part of the Columbia Basin system. To accomplish this objective, reservoir uses for flood control, power generation, recreation, fish and wildlife, and water quality are considered. It must be realized that these uses may sometimes conflict and choices must be made for the greatest overall benefit. The degrees of constraint listed in paragraph 7-02 give a means of resolving conflicting interests.

7-02 Constraints.

The major constraints on operation of Dworshak project are:

- Spillway and outlet operation.
- Minimum flow releases.
- Maximum stage rate of change downstream.
- Control of downstream temperature.
- Lower Snake flow augmentation releases (fish flows).

a. Spillway and Outlet Operation. Three regulating outlets and two spillway bays provide a means of releasing water in excess of power requirements. The desired release may be obtained using either the outlets, the spillway, or a combination of both provided, of course, the reservoir level is above the spillway crest elevation 1545. The following criteria should be followed when making releases:

(1). Balance Releases. Releases will be balanced as much as possible in order to establish and maintain uniform flow patterns through the spillway-stilling basin. This type of operation reduces adverse hydraulic conditions, which cause structural damage by erosion of the concrete.

(2). Operational Limitations.

(a). Spillway (Gate Opening):

1. For opening requirement of 1 foot or one increment, use one gate only. Either gate may be used.

2. For opening requirement greater than 1 foot, use both gates opened equally when possible.

CAUTION: In no instance should a difference of more than 1 foot of gate opening between the two gates be permitted during normal operation for spillway releases.

(b). Outlets (Valve Opening):

1. For opening of 1 foot or two increments, use outlet number 2 only.

2. For opening requirement greater than 1 foot, use balanced outlets 1 and 3 or three outlets equally balanced within one increment of each other.

CAUTION: In no instance should a difference of more than one increment (6 inches) of valve opening between three valves by permitted during normal operation for outlet works releases. Valves No. 1 or No. 3 should not be operated singly under any circumstances.

If an emergency prevents meeting the above criteria, a report should be made to NPW Engineering Division detailing the circumstances so that the possibility of stilling basin damage can be evaluated.

Model studies indicate the sidewalls of the spillway may be overtopped by flows in excess of 100,000 cfs, flooding the power house. Table 2-1 gives the discharge rating for a single spillway bay. Table 2-2 gives the discharge rating for a single outlet.

b. Minimum Release. The minimum instantaneous project release will be 1,000 cfs. This minimum flow has been established as necessary for fish collection at the dam and as a water supply for the hatchery. Although the hatchery is operated as essentially a closed, recirculating water system, about 10 % makeup water is required. North Fork water is required for this purpose because fry reared in North Fork water are more likely to return to North Fork and the hatchery when seeking spawning areas as returning adults. Trapping facilities to supply the hatchery are located on the North Fork and hatchery stocking depends upon adult steelhead returning to North Fork.

c. Maximum Rate of Change. A 1-foot-per-hour (1 foot in any 60-minute period) rate of stage change in the Clearwater River at the Peck gauging station due to releases from Dworshak is the maximum rate of river fluctuation allowed. This 1-foot-per-hour maximum limit is set to protect downstream river user activities and facilities. The allowable hourly rate of change of project discharges for this stage rate of change at Peck is determined by the initial riverflow at Peck at the time of the change. Table 7-1 gives the maximum allowable 1-hour change in discharge at Dworshak for a range of observed flows at Peck. It should be noted that the 1-foot change at Peck can generate a change of up to 5 feet on the North Fork between the dam and the main stem Clearwater. If at all possible, flows should be stepped up gradually, especially during the fishing or recreation season, when heavy public use occurs downstream on the North Fork. The NPD RCC is responsible for determining ramp rates when changes in project discharge are required.

d. Temperature Control of Release. The multi-level outlet facility is provided to select the temperature of water discharging through the turbines. The initial operating objectives were to match the temperature of the water in the Clearwater River just above the North Fork and maintain acceptable levels of dissolved oxygen. However, during the initial operation of the project this type of regulation released water that was too warm for the Federally operated fish hatchery downstream of the dam and too warm to efficiently cool the powerhouse generators.

An interim plan was developed in 1974 to provide cooler water for the generators and hatchery. Under this plan, $53^{o}$ F releases are maintained whenever possible, with discussions between project and hatchery personnel being held weekly to discuss temperature conditions. This plan remains in effect to the present time.

The selector gates are set for use in May, but the $53^{o}$ F temperature desired usually cannot be achieved until early July. The reservoir usually becomes too cool to maintain this temperature in November, at which time the gates are used to provide as warm a temperature as possible.

To prevent kokanee loss through the turbines, it is desirable to draw water only from the top 50 feet of the reservoir from January to April. Withdrawal of reservoir water from over the top of the selector gates is possible with reservoir fluctuations between elevations 1600 and 1500. Between elevation 1500 and minimum elevation 1445, water must be drawn from beneath the gates.

e. Lower Snake Flow Augmentation. PL 96-501, Pacific Northwest Electric Power Planning and Conservation Act (December 1980) contains provisions to protect, mitigate, and enhance conditions for fish and wildlife on the Columbia River and tributaries. To accomplish this, the Northwest Power Planning Council was established and in 1982 developed a comprehensive Columbia River Basin fish and wildlife program. The most significant part of the program establishes a “Water Budget” approach, which allocates a total Water Budget of 20 kcfs-months (1.19 MAF) at Lower Granite Dam for flows in excess of firm power flows from 15 April to 15 June. The participation of Dworshak in the fish flow augmentation program at Lower Granite is summarized as follows:

(1). Water Budget Regulation. During a water budget year (Lower Granite runoff volume inflow forecast for April through July is 23.0 MAF or less), the regulation of Dworshak for coordination of the Water Budget will be based on the “Annual Coordinated Plan of Operation” developed by the Corps of Engineers for the period 15 April through 15 June. The RCC will be responsible for coordinating Dworshak releases to the extent that water is available for fish flows at Lower Granite. Requests for release of additional flow will originate with the Water Budget Center.

(2). Non-Water Budget Regulation. During a non-water budget year (Lower Granite runoff volume inflow forecast for April through July is greater than 23.0 MAF), the RCC will also coordinate the regulation of Dworshak releases to the extent that water is available for flow augmentation at Lower Granite.

7-03 Overall Plan for Water Control.

a. Annual Operating Plans. In accordance with the Pacific Northwest Coordination Agreement, each year prior to 1 February the Division office will submit to the Pacific Northwest Power Pool Coordinating Group required operating rule curves and any operational constraints for Dworshak for the next succeeding operating year. The rule curves and constraints will reflect to the extent possible the constraints and considerations contained in this manual. The District and Division offices will coordinate fully in preparing this submittal.

The Coordinating Group will then prepare system regulation plans for the next operating year (1 July – 30 June) which will be reviewed by the Division and District offices to insure that the regulation plan for Dworshak project has been made in accordance with the operating objectives stated in this manual. The operating plan developed in the project, based on the 1 February data submission, will be in effect only for the next operating year, for the period of 1 July to the following 30 June. Refer to the Columbia River Basin Master Water Control Manual dated December 1984 for details on annual planning and analysis for system operations.

b. Seasonal Operation. Seasonal operation of the project will be governed by the principles of the Pacific Northwest Coordination Agreement, the appropriate operating plan, and special rules established specifically for Dworshak project for nonpower purposes.

Generally, seasonal storage use will comply with established storage levels indicated by the Operating Rule Curve which is developed from the Coordinating Group simulated system regulations for each reservoir in the coordinated hydroelectric system. The main purpose of the Operating Rule Curve (ORC) is to insure the system's FLCC, with the recurrence of the most adverse historical water supply. The ORC insures reservoir storage refill in all but the years of low runoff. Through the data submittal process as stated in paragraph a. above, it also recognizes nonpower constraints and in certain periods of the year, may be a direct function of such constraints, for example mandatory draft for winter flood control space.

The overall seasonal storage plan of Dworshak is summarized as follows:

(1). September-December. Draw down reservoir to elevation 1558 by 15 December to provide 700,000 acre-feet of flood control space. This should be accomplished by using normal power load discharges.

(2). January-March. Maintain 700,000 acre-feet of storage plus any additional required based on volume forecasts of available runoff.

(3). April-July. Refill at a rate that will provide safe flood control based on runoff volume forecasts, yet will allow a 95 % probability of refill.

(4). July-August. Attempt to hold full pool or maximum elevation achieved during refill.

In actual operation the storage levels attained at Dworshak Project will be near those levels indicated by the ORC most of the time. On some occasions the levels may be higher or lower than those indicated by the curve. Examples of these occasions are as follows:

- Water is surplus to power needs.
- Water is stored for flood control.
- Water is being stored for another utility by energy exchange agreement.
- The system FLCC cannot be maintained without additional drafts.

If the reservoir must be drafted below its ORC, then it will be operating in the same proportion between its ORC and appropriate Critical Rule Curve as other reservoirs in the Coordinated System.

## 7-04 Standing Instructions to Dam Tenders.

The following is a list of standing instructions for reservoir regulation under normal conditions, emergency conditions, communication outage, and system power outage.

a. Normal Conditions. Dworshak Reservoir will be regulated according to criteria and procedures in this Water Control Manual. Appendix A of this manual (separate publication) contains pertinent project rating tables and curves. The following tabulation lists locations of normal operating criteria within this manual.

Tables



b. Emergency Conditions. Emergency conditions are unforeseen and cannot be provided for in this Water Control Manual. Reference should be made to the Flood Emergency Subplans for Dworshak for emergency procedures associated with dam safety.

Should an emergency occur or appear to be developing, the Project Engineer or his representative should contact his immediate supervisor. If the nature of the emergency requires immediate action to prevent loss of life and property, the Project Engineer will take the necessary action and report all circumstances to the NPW Chief of Operations, Construction, and Readiness Division as soon as possible. If the emergency affects power or downstream water conditions, the RCC will be notified immediately.

NOTE: **Refer to the Emergency Regulation Assistance Procedures in the front of the manual for telephone numbers and guidelines on emergency conditions.**

c. Communications Outage. In the event of normal telephone and CBTT systems outage, communication between the Dworshak project and the RCC will be established via the NPW radio system.

d. System Power Outage. In the event of a transmission system breakup, which would leave Dworshak project the only major generating facility on an isolated segment of the BPA system, a maximum effort will be made to carry the load. Under such conditions, it may be justified on a short-time basis to load the generators above the normal 15 % overload, which may draw down the reservoir below the level allowed by the ORC. If at all possible, at least one generator will be kept in operation throughout an emergency, which has isolated or threatens to isolate the project from other power sources. If no other power is available, the spillway gates may be operated with emergency power supplied by a diesel-generator set.

7-05 Flood Control.

The flood control plan involves three periods seasonally for reservoir regulation. These are: (1) reservoir evacuation period (normally the drawdown period from September through March); (2) reservoir refill period (normally the high flow period from April through July); and (3) storage holding period (normally coincident with the summer recreation period (July and August). Plate 7-1 shows operating curves for flood control and Plate 7-2 shows variable refill curves.

a. Winter Food Control (September-December). The reservoir level is scheduled to be lowered to a maximum elevation of 1558 by 15 December each year. This will provide the 700,000 acre-feet of reservoir space needed for winter flood control in the event that a winter flood freshet should occur. Normally, system power loads will be scheduled to provide the space required. Necessary drawdown will be accomplished using the following schedules:

(1). From 1 September to 1 October, the pool will be regulated to achieve an elevation between 1586 and 1560 by 1 October. Pool elevation 1586 provides about 250,000 acre-feet of flood storage space. Releases during this period should average about 4,200 cfs above inflow if the reservoir was full on 1 September.

(2). From 1 October to 15 November, the pool will be regulated to achieve an elevation between 1579 and 1560 by 15 November. An additional 120,000 acre-feet of flood storage space is available between elevations 1586 and 1579. During this period, the 7-day average release cannot exceed inflow by more than 1,300 cfs, except during freshets or emergency power operations. Maximum change in any day shall not exceed 40 % of the previous 7-day average release. This restriction is imposed to provide favorable “catch” conditions during the prime steelhead fishing seasons and will be continued unless it is demonstrated and agreed to by State of Idaho and Federal fisheries agencies that high flows and fluctuation pose no serious reduction in fish harvest. It is also an operational objective to maintain elevation 1560 until 1 November to allow boat access and campsite use during the fall hunting season. However, the reservoir may be evacuated below this level during October if critical power situations justify the action.

(3). During the period from 16 November to 15 December, the pool will be regulated to achieve elevation 1558 or lower to provide the remaining space needed for 700,000 acre-feet of total flood storage space. This amount of storage space, as a minimum, will be maintained until after 1 April. Additional space may be required for power or flood control based on volume forecasts made after 1 January.

In some years, winter flood freshets are expected to occur which will require storage in the upper elevations of the reservoir. The rates and amounts of storage will be determined on a real-time basis for control of floods in the lower Columbia River as gauged in the Portland-Vancouver area and on the lower Clearwater River as gauged at Spalding, Idaho. In the absence of advance instruction covering a significant rise in the Clearwater River, releases from Dworshak should not exceed 20,000 cfs and flows at Spalding should not exceed 115,000 cfs until regulation instruction are received.

Whenever it is necessary to store in the winter flood control space, the full space requirement should be regained as soon as possible by maintaining approximately the maximum flows observed at Spalding during the freshet, but not to exceed flood stages downstream. For this purpose, downstream flood stages will be considered as 115,000 cfs at Spalding and 16 feet at Vancouver, Washington. The following Table 7-2 summarizes the fall drawdown requirements as discussed in the preceding paragraphs.

## TABLE 7-2

## SUMMARY OF FALL DRAWDOWN REQUIREMENTS

| Period | Pool Elev. Min. | Pool Elev. Max | Release Over Inflow – cfs | Fluctuations Permitted | Total Space (a.f.) | Notes |
|---|---|---|---|---|---|---|
| -1 Sep | 1570 | 1600 | 4200 | | 250,000 | Release does not have to be uniform. |
| 1 Sep-1 Oct | 1560 | 1586 | | | | |
| 1 Nov | 1560 | | | | | A constraint. Certain procedures of notification and justification will be required prior to violation. |
| 1 Oct-15 Nov | | 1579 | Max 1300 | Max. change in any day not to exceed 40% previous 7-day average outflow. | 370,000 | Prime steelhead fishing season. Fluctuations are critical. |
| 16 Nov-15 Dec | | 1558 | 5500 | | 700,000 | Spill required 25% of all years with 3 units available. |

b. Spring Evacuation (January-March). Spring evacuation operations are guided by runoff volume forecasts made during the period 1 January to 1 April. The operational objective during this period is to obtain, by 1 April, the amount of storage space that is required for flood control and can be safely refilled before 31 July (based on runoff forecasts and Plate 7-1 and Plate 7-2. A seasonal forecast procedure, Exhibit 7-1, utilizes available precipitation and snowpack data to forecast runoff volumes. Forecasts of runoff volume for the period 1 April to 31 July are made approximately every 2 weeks (near the beginning and middle of the month) beginning on 1 January and continuing until the flood season is over.

Normally, the evacuation discharge rate for spring flood control will be determined as the average discharge required from the current date to 1 April to provide the desired evacuation space. Evacuation for spring flood control should be accomplished, if possible, prior to 1 April to avoid increasing the spill and nitrogen supersaturation at downstream projects. Project releases will be selected as inflow plus the evacuation discharge rate. Adjustments will be made periodically as the season develops and runoff forecasts are updated.

c. Reservoir Refill (April-July). The space evacuated for flood control will be maintained until refill operations are required. The refill parameter curves, Plate 7-2, show the maximum space from 1 January to 31 July that has a 95 % chance of being refilled with a given runoff forecast and a minimum power discharge requirement of 2,000 cfs. The parameter curves conform to the “Variable Refill Curve” criteria described in paragraph 7-10.b.(5) and shown computed on Exhibit 7-1. Variations in average power releases could result in more space available than indicated by the refill parameters, in which case the parameter curves will allow for estimating the amount of risk to refilling that may be involved. Considerations will also be given to reducing daily fluctuations form 25 April to 30 June for spring chinook fishing.

One strict limit to the final refill operation is imposed to assure capability to pass the spillway design flood in the event of a severe rainstorm during the spring snowmelt season. This limit is the retention of inviolate flood control space according to the following table:

| **Percent of Area Covered By Accumulated Winter Snowpack** | **Inviolate Space Reservation 1,000 A.F.** |
|---|---|
| 100 | 700 |
| 80 | 540 |
| 60 | 383 |
| 40 | 230 |
| 20 | 80 |
| 10 | 0 |

Snow covered area is considered to include only accumulated winter snowpack and should not be used for late spring snowstorms which will cover a large area without producing substantial runoff. This snow covered area is determined by use of the SSARR model, by aerial snow reconnaissance of the Clearwater River Basin by NPW Hydrology Branch personnel, and by satellite imagery. The two latter sources are considered the most reliable and will govern over the SSARR model data when in disagreement.

d. Summer Recreation (June – August). The period following the spring refill is an annual period of highest reservoir elevation and corresponds to the period of greatest recreation use of the reservoir. During the summer recreation period, the reservoir level should fluctuate as little as possible until the autumn drawdown period. The reservoir should normally be held full during this period unless critical conditions develop such as power shortages. If the reservoir does not fill to that level, it will be held at or near the maximum level reached. Maximum drawdown elevation prior to 1 September will be 1,570 feet msl. The normal operating practice is to wait until after Labor Day weekend to begin drawdown.

## 7-06 Recreation.

Because of its desirable location in a mountainous forested region, Dworshak Reservoir is unique among reservoirs in the region and is quite popular for boating, fishing, water skiing, hunting, camping, and many other recreational uses. Because of this great demand, recreation use of the reservoir is an important element of the water control plan. Plate 2-9 shows the reservoir map and Plate 2-10 shows regional recreation facilities.

An operational objective of the Dworshak project will be to fill to normal pool elevation 1600 each year and to maintain the reservoir at normal pool during the summer months to facilitate boating, camping, and other recreational activities. Pool levels less than full leave beaches separated from the water by a strip of mud, lengthen boat launching ramps beyond convenient lengths or make them entirely unusable, isolate camping sites from the shoreline, and generally deteriorate recreation quality. Reservoir drafts greater than 5 feet below full pool (1,600 feet msl) affect swimming, campsite access, and shoreline fishing; and drafts greater than 10 feet below full pool makes boat launching more difficult as well as affecting recreation activities. Table 2-6 shows reservoir levels at which specific recreation sites are operational.

Special consideration will be given to avoid evacuating the reservoir during winter or spring months below the level that will assure at least a 95 % chance of refilling to elevation 1570 by 1 July. Evacuation below this level will seriously restrict or eliminate use of the summer recreational facilities. The decision to evacuate below this level will be made only after evaluating: (1) availability of power from other sources, (2) current recreational demand at Dworshak and the related impact of lowering the pool, (3) availability of water from other projects in the system where evacuation would not have a similar impact on recreation, and (4) availability of water at other projects where similar recreational impacts will occur but the recreational use is significantly less than at Dworshak. This decision should include consideration of availability of other similar recreational facilities in the area to which the recreation activities could logically be transferred.

During the fall hunting season, many hunters use boats to gain access to the regions of the upper reservoir. Because of this, it is desirable to maintain pool levels that will keep boat launching ramps operational until November, i.e., above elevation 1560.

7-07 Water Quality.

7-08 Fish and Wildlife.

Reservoir discharge operations and especially fluctuations in discharge can have a great effect on fish and wildlife downstream of the dam. The following constraints should be followed when making changes:

a. During the 1 October to 15 November prime steelhead season, maximum change of project discharge shall not exceed 40 % of the previous 7-day average release.

b. Consideration should be given to reducing daily fluctuations from 15 February to 15 April for spring steelhead runs. A reduction in fluctuations may also be requested after the 1 October to 15 November special regulation period by the Idaho Department of Fish and Game.

c. From 15 February to 15 April, geese will be nesting along the lower river. When feasible, reservoir evacuation during this period should be made at a uniform or a decreasing rate to avoid flooding goose nests after they are established.

d. Bass spawn in the lower Clearwater River below the North Fork each year. The time of spawning varies from year to year, it may be as early as mid-June or as late as mid-July. To avoid dehydration of the spawn, it is desirable to minimize streamflow recession on lower Clearwater River for about a 2-week period. Operations for this purpose will be coordinated with the Idaho Fish and Game Department.

e. To provide the proper temperature for the Federal fish hatchery downstream, water is withdrawn from a layer that provides $53^{o}$ F temperature water whenever possible.

f. Dworshak Reservoir may also be used to augment flows on the lower snake from 15 April to 15 July to aid in the outmigration of salmon and steelhead past the dams. The NPD RCC will issue instructions for adjusting the flows from Dworshak if necessary to meet the needed flows in the lower Snake. Flow requirements will be based on the annual water budget plan developed by the Corps and the Water Budget Center.

7-09 Water Supply.

a. Dworshak National Fish Hatchery

See the Memorandum of Understanding Between the Clearwater Fish Hatchery, Dworshak National Fish Hatchery and the US Army Corps of Engineers Dworshak Project For the Operation and Entrance Requirements for the Hatchery Water Supply System.

7-10 Hydroelectric Power.

A power regulation plan for Dworshak, insofar as it affects nonpower functions, will be submitted to the Coordinating Group, the Northwest power Planning council, annually. This plan should be submitted by 1 February each year. The District and Division offices should coordinate in preparing this regulation plan and the submitted plan shall have received full concurrence by the District.

a. Scheduling Power Operations. Power operations are scheduled through the NPD RCC and the Power Scheduling Section of BPA. The action is initiated when the RCC determines how much water can be released from the reservoir during a certain period of time without violating constraints or procedures outlined in paragraph 7-15, Deviation from Normal Operations. This is submitted to the Power Scheduling Section which review it and requests the releases to follow a certain schedule. This schedule could call for a peaking operation, block loading, or base loading. The load schedule is relayed to the project by the CBT under normal conditions. When the CBT is not operational, communication is accomplished via radio or telephone (microwave, FTS, or commercial). For more information on power scheduling, refer to the Columbia River Basin Master Water Control manual dated December 1984, Section 9 – Power Scheduling.

b. Power Generation. Annual and seasonal power operating limits are defined by provisions of the Pacific Northwest Coordination Agreement (Contract No. 14-02-4822) described in the Columbia River Basin master Water control manual dated December 1984. Reservoir regulation for power generation is governed by several rule curves, which are a graphical representation of the maximum and minimum elevations the reservoir may be at any given time of year. Details on the computation of rule curves for power operation are described in Section 7, Methods For Developing the annual Operation program, of the Columbia River Basin master Water Control Manual. Explanations of these rule curves are as follows:

(1). The Upper Rule Curve (URC) defines the maximum elevations allowed by flood control requirements. Each year the URC will vary as a function of the August-December historical flows, January-July runoff volume forecast. This constraint is not expected to change significantly during the project life (although the rule curve may) and represents a minimum reservoir draft to provide space for flood control. The minimum level allowed will usually not be below the Variable Refill Curve.

(2). The Critical Rule Curve (CRC) is determined annually by the Northwest power Pool coordinating Group on the basis of annual estimates of system loads and resources. The CRC is the schedule of reservoir levels necessary for the reservoir to meet its share of the system firm load during the critical period. The critical water period is the period in which the Coordinated System might be expected to encounter the most difficulty in serving its firm load requirements. One critical water period for the Coordinated System is the 42-month period between 1 September 1928 and 29 February 1932. Another historical period, the 20-1/2-month period between 15 August 1943 and 30 April 1945, produces an almost equally low energy capability.

(3). The Assured Refill Curve (ARC) defines the reservoir elevations necessary to refill the reservoir by 31 July based on conservative estimates of the amount of inflow available. The amount of natural flow available for refill is the second lowest volume inflow from natural flow which has occurred in any comparable period in the historical period of record beginning July 1928. Such available natural flow will be reduced by deducting all discharge requirements, including minimum release requirements and all nonpower discharges.

(4). The Base Energy Content Curve is the higher of the CRC from the first of the year of the critical period and the ARC.

(5). The Variable Refill Curve (VRC) also called the Variable Energy Curve (VECC), indicates reservoir levels to which drafts can be made to serve nonfirm loads and assure a 95 % chance of refill while serving firm loads during the 1 January-31 July period. The VRC provides for drafts below the Base Energy Content Curve by the amount the forecasted volume inflow is in excess of total requirements for refill of the reservoir, power discharge requirements, and nonpower requirements for water. The VRC shall be such that the reservoir returns to normal top elevation by the end of July. A sample computation of a VRC for a power discharge requirement of 2,000 cfs is shown on Exhibit 7-1.

(6). The ORC is defined as follows: from 1 August to 31 December, the ORC is the higher of the CRC and ARC. Between 31 December and 31 July, the ORC is the higher of the CRC or ARC unless the VRC is lower. In either case, the ORC may not be higher than the URC, as this would not provide adequate flood control space. NPD RCC is responsible for determining the ORC for Dworshak Reservoir. The ORC defines what levels a reservoir may not be drafted below to service nonfirm loads. During some years of low runoff, power drafts to serve firm loads will cause the reservoir to be drafted below a level indicated by the ORC.

c. Provisional Storage Draft.

(1). Background. On 30 June 1982, the Corps of Engineers (NPD), the Pacific Northwest Region Bureau of Reclamation, and the BPA entered into a Provisional Draft Agreement (BPA Contract No. DE-MS79-82BP90930) pertaining to the operation of Dworshak, Libby, Hungry Horse, and Grand Coulee. The agreement:

(a). Permits provisional energy production as defined in the Pacific Northwest Coordination Agreement (BPA contract No. 14-03-48221).

(b). Prescribes the maximum permissible storage drafts for the production of advance energy.

(c). Provides for the return of provisional draft.

The following paragraphs summarize procedures contained in the agreement relating tot he operation of Dworshak for the delivery of advance energy and return of provisional storage drafts.

(2). Provisional Storage Draft for Advance Energy. Under the agreement, provisional draft of Dworshak, Libby, Hungry Horse, and Grand Coulee reservoirs can only occur between 1 August and 10 January. Provisional draft occurs when reservoirs are drawn down below the level that is required to serve firm power. Regulation for provisional draft produces additional energy called advanced energy that BPA may use to make additional sales or serve interruptible industrial loads. Allowable amounts of provisional storage draft for the delivery of advance energy, as shown in the following tabulation, have been established for each reservoir such that the resulting reservoir elevation will not have a major adverse impact nonpower uses.

| | Allowable Initial Provisional Storage Draft for Advance Energy Production1 August through 1st Monday of September[1] | | Allowable Total Provisional Storage Draft Below the Lower of the ECC or Proportional Draft Level for Advance Energy Production[2] | |
|---|---|---|---|---|
| | Storage Draft[3] | | Storage Draft[3] | |
| Reservoir | Limit KSFD | Approx.Feet | Limit KSFD | Approx.Feet |
| Grand Coulee[4] | 111 | 2.8 | --- | --- |
| Libby | 64 | 2.8 | 193 | 8.5 |
| Hungry Horse | 31 | 2.8 | 95 | 8.5 |
| Dworshak | 27 | 2.8 | 82 | 8.5 |
| Total | 233 | | 370 | |

[1]Initial delivery of advance energy would occur only if the coordinated system's total storage energy had reached 98 % of full by 31 July and the listed reservoirs had filled to within 5 feet of full prior to the first Monday of September (Labor Day).

[2]if the conditions shown above in footnote 1 are not met, there will be no provisional storage draft for advance energy until the coordinated system and the listed reservoirs fill above their ECC.

[3]Storage draft is based on the average amount of water per foot of elevation in the top 10 feet.

[4]Draft to be refilled as soon as possible after the first Monday in September.

At Dworshak, the allowable initial provisional storage draft (2.8 feet) from 1 August through the first Monday of September (Labor Day) plus other draft indicated by the first-year CRC for firm energy production cannot exceed 5 feet from full pool (elevation 1595). From 1 August through 10 January, the allowable total provisional storage draft is limited to an accumulated 162,600 acre-feet (approximately 8.5 feet) below the storage content which the reservoir would have attained to meet system loads.

(3). Return of Provisional Storage Draft. After 10 January, BPA has an obligation to return all the provisional storage draft between 1 February and 31 July for refill of water up to the equivalent of the amount of advance energy that has been delivered from the reservoirs when the following conditions are met:

(a). The first of month January to July forecast volume runoff for the Columbia River at the Dalles, Oregon, is greater than 70 million acre-feet.

(b). The actual elevation of the reservoir is below or is projected to be below a 75 % probability of refill level.

The water is returned by reducing BPA's firm load and the reservoir's outflow (as limited by nonpower requirements). This allows the reservoir to return to a level it would have reached without provisional storage draft for advance energy. NPD and/or the Bureau of Reclamation may waive requirements for the return of the provisional storage drafts for their respective reservoirs and allow provisional storage drafts to be carried over to the next operating year.

7-11 Navigation.

Navigation is one of the important water uses in the development of the Columbia and Snake Rivers. Normally, navigation requirements are met with regulation of stream flows and pool levels for other project purposes. Occasionally, however, special requirements are met by special regulation of pool levels, but these do not significantly alter the Columbia River regulation as a whole.

The locks at the dam may be closed for brief periods every year for maintenance. Closures are scheduled far enough in advance and given sufficient publicity to provide minimum interference with navigation.

7-12 Drought Contingency Plans

The following factors affect the operation of the Dworshak project during the drought. First, Dworshak is operated as part of the Columbia River reservoir system under all conditions including droughts. A drought in a region of the Columbia River basin may affect the operation of projects not directly affected by or in the drought region. Therefore, since Dworshak is regulated as part of the Columbia River reservoir system, the DCP contained in Section XII of the Columbia River Basin Master Water Control Manual dated December 1984 will serve as a general and system plan. Second, the release of water from Dworshak storage for (1) Water Budget (15 April - 15 June), (2) Summer flow augmentation (16 June – 31 August), and (3) fall flow augmentation (1-30 September) has become a major function of the project as a result of the following factors:

1. PL 96-501, Pacific Northwest Electric Power Planning and Conservation Act (December 1980);
2. Endangered Species Act of 1973, PL 93-205, which lead to the National Marine Fisheries Services listing the Snake River sockeye salmon, spring/summer Chinook, and fall Chinook salmon as endangered.

As a result other authorized project functions (power, recreation, and lake navigation) have become subordinate to the need to provide augmented and increased flows from Dworshak for anadromous fish.

7-13 Flood Emergency Action Plans

7-14 Other

Experience in the operation of Columbia River reservoirs indicates that requests form public and private organizations and individuals for special operations affecting the downstream river can be expected. Such requests usually cover a wide range of activities and may include fish migrations, recreation water levels and temperatures, hydroplane races, group float trips, industrial activities, search and rescue activities, and perhaps others. It can be expected that such requests will conflict with one or more other operating functions. Such requests for special downstream operations will be evaluated and approved or denied by RCC in consideration of current conditions.

7-15 Deviation from Normal Regulation

a. Emergencies

Normally, operational objectives can be accomplished within the constraints described. When reservoir operational conflicts do occur and it is deemed necessary to violate one or more operational constraints, careful consideration must be given to the probable consequences. Constraint violations should produce minimal negative public benefits, for both Dworshak and the other Columbia system projects, as compared to other possible alternatives. As an aid for solving operational conflicts which may arise, constraints are grouped into three levels or degrees of constraint. These three levels of constraint are as follows:

(1). Level 1. This is the highest degree of constraint and will not be violated except during unforeseen emergencies. Concurrence of Division and District engineers will be obtained prior to violation if possible. When immediate action is required, the Division and District engineers will be notified as soon as is feasible following the action.

(2). Level 2. Level 2 constraints are those constraints which can be violated with requirements: (1) consideration of all other alternatives to avoid violation, (2) consultation with the District Engineer to explain necessity and alternatives, and (3) notification of other interested agencies, organization, and officials or individuals as soon as possible.

(3). Level 3. Level 3 is the lowest degree of constraint and can be violated at the discretion of the NPD.

The operational constraint items are listed in the following Table 7-3 with the appropriate level of constraint.

**TABLE 7-3**

**DWORSHAK OPERATIONAL CONSTRAINTS**

| Level | Degree of Constraint | Operational Items |
|---|---|---|
| 1 | Not to be violated except during extreme emergencies. | a. 1,000-cfs minimum flow.<br>b. 700,000 acre-feet minimum winter flood control (15 December-1 April).<br>c. Snow-covered area versus flood control space. |
| 2 | Can be violated with requirements of:<br>a. Consideration of all other alternatives to avoid violation.<br>b. Consultation with District Engineer to explain necessity and alternatives.<br>c. Notification of other interested agencies, organizations, and officials or individuals as soon as possible. | a. Rate of change of release.<br>b. Schedule of winter flood control evacuation.<br>c. Spring evacuation based on runoff volume forecast.<br>d. Limitations of fluctuations during fall steelhead season.<br>e. Evacuation below ability to refill to elevation 1570 by 1 July with 95 percent certainty.<br>f. Evacuation below elevation 1570 from 1 June to 1 September.<br>g. Evacuation below 1560 from 1 September to 1 November. |

| | | |
|---|---|---|
| 3 | Can be violated at discretion of NPD. | a. River fluctuation during spring steelhead season.<br>b. Evacuation below ability to refill to 1600.<br>c. Evacuation below 1600 from 1 June to 1 September.<br>d. River fluctuation during goose nesting.<br>e. Streamflow recession during bass spawning. |

b. Unplanned Minor Deviations

c. Planned Deviations

7-16 <u>Rate of Release Change</u>

# 8 EFFECT OF WATER CONTROL PLAN

8-01 General.

The various water control plans are intended as a means of outlining project regulation and/or management practices that maximize benefits derived from the project. These water control plans provide for flood control, power generation, water quality, recreation, fish and wildlife, and log handling. The overall benefits and effects of the project are summarized as follows:

- Flood Control. Regulation of the project is effective in controlling floods on the lower Clearwater River and the lower Snake River.

- Power. Another benefit credited to the project is the optimum generation of electric power both from onsite generators and downstream powerplants which produce energy from Dworshak releases.

- Water Quality. Dworshak provides water suitable for use by the fish hatchery. In addition, project releases provide cooler summer flows which enhance downstream fishery and warmer winter flows which have eliminated ice jams in the lower Clearwater downstream from the confluence of the North Fork and the main stem. Periods of spill from the project occur infrequently, and the adverse effects of gas supersaturation have not had a permanent effect on the downstream ecosystem.

- Recreation. The Dworshak Project makes a significant contribution to recreation activities in the Clearwater area. Visitation information indicates that about 75 % of the use of Dworshak Project facilities originates from areas less than 50 miles away. Regulation of the project provides a high, stable pool which is excellent for water-oriented recreation activities during the summer months of each year.

- Fish and Wildlife. The regulation of the project maintains a high, stable pool which also provides benefits for both sport fishing on the lake and wildlife within the reservoir area. Water temperature regulation helps meet needs of the downstream hatchery and enhances the trout fishery on the lower Clearwater River. The regulation objective limiting changes in project releases in order to minimize fluctuations in the lower Clearwater River during the prime steelhead fishing season from 1 October to 15 November helps to enhance downstream sport fishing. Regulation during spring months assists the downstream migration of anadromous fish.

The various water control plans are intended as a means of outlining project regulation and/or management practices that maximize benefits derived from the project. These water control plans provide for flood control, power generation, water quality, recreation,

fish and wildlife, and log handling. The overall benefits and effects of the project are summarized as follows:

8-02 Flood Control.

Flood control is an important function of the Dworshak Project. Dworshak provides flood protection for the lower Clearwater area from Ahsahka to Lewiston and aids in the control of lower Snake River floods. Development of flood control criteria is based on the regulation of historic natural floods, standard project floods, and the probable maximum flood. Flood control releases at Dworshak are limited by downstream channel capacities, and out-of-bank discharges start at about 115,000 cfs at Spalding. The lower reach of the main stem Clearwater River from the former Washington Water Power damsite to the mouth, including the Potlatch Forest, Inc., paper and plywood mill and city of Lewiston, Idaho, are considered to be protected by the Lewiston levees for flows up to 150,000 cfs. Regulation by Dworshak is essential to limit the standard project flood and lesser floods to 150,000 cfs or less at Spalding for the protection of Lewiston by the levees.

a. Historic Natural Floods Regulation.

(1). Winter. During the 43-year record period from October 1926 to September 1969, five notable winter freshets occurred. They were in November-December 1927, December 1933-January 1934, December 1946, December 1944, and December 1964. In all five occurrences, the discharges of lower Clearwater River at Spalding, Idaho, would be controlled to nondamaging rates by controlling Dworshak releases to 20,000 cfs or less on a forecast basis. The highest recorded discharge at Dworshak was 100,000 cfs on 23 December 1933 with a concurrent discharge of 172,000 cfs at Spalding. This flood at Spalding would have been regulated to 90,000 cfs by use of Dworshak. Graphic illustrations of winter freshet control are shown on Plate 8-1.

(2). Spring. Simulated regulation of some of the major spring floods of record that would have occurred with Dworshak operating in the Columbia River system are also shown on Plate 8-1. The examples are for floods of 1943, 1948, 1950, 1956, and 1957. In this simulation, substantial storage was begun in mid-April of the 1943 and 1956 floods to adjust for reduced forecasts of volume runoff made at the time. During the 1948 flood simulation, it was necessary to increase Dworshak outflow from 4,000 cfs to 10,000 cfs on 1 June to accommodate substantially increased forecasts of runoff made at that time. The flood control storage season from about 1 May to about mid-June at Dworshak is adjusted as necessary on real-time basis to coincide with high rates of flood runoff on lower Clearwater and Columbia Rivers.

b. Winter Standard Project Flood. The winter standard project flood inflow for Dworshak was determined during early 1973 using a unit hydrograph study on the Clearwater River Basin and is subject to revision. The winter standard project flood has an 11-day winter rainstorm of 8.7 inches of precipitation as compared to 5.8 inches in 8 days during the December 1933 flood. During the 11-day storm of 8.7 inches, 5.5

inches of precipitation occurred in a 3-day period and was accompanied by warm winter temperatures. The resultant 11-day runoff volume is 1,300,000 acre-feet or 9.9 inches, including snowmelt.

The winter standard project flood was regulated using 700,000 acre-feet of storage space and the following criteria:

(1). Maintain flood control space by adjusting releases based on the previous day's inflow until flow at Spalding exceeds 100,000 cfs (20-22 December).

(2). Control to 150,000 cfs at Spalding insofar as possible without exceeding 30,000-cfs discharge until recession begins (22-24 December). After recession becomes evident, adjust discharge to maintain approximately 150,000 cfs at Spalding to evacuate the reservoir.

(3). Recover original 700,000 acre-feet of space as soon as possible using 75,000-cfs release when possible (24-31 December). With this operation, 700,000 acre-feet of flood storage space was regained by 1 January. The standard project flood peak can be reduced at Spalding from 280,000 cfs to 150,000 cfs by this regulation, which is shown on Plate 8-1.

c. Spring Standard Project Flood. The spring standard project flood inflow for Dworshak was determined in 1943 in connection with the Review Report on Columbia River Tributaries, Middle Snake River Basin. The derivation is described in Section 4 of Design Memorandum No. 1, Bruces Eddy (Dworshak) Dam and Reservoir. The standard project flood has a snowpack water equivalent at the beginning of the flood season of 42 inches. The resultant 1 May through 31 July runoff volume is 4,400,000 acre-feet, or 33.8 inches, including runoff season rainfall contribution.

The standard project flood was regulated using the following criteria and is shown on Plate 8-1:

(1). Evacuate reservoir to minimum pool elevation based on rule curves shown on Plate 8-1.

(2). Pass inflow until reduction is required to prevent Spalding flows from exceeding 105,000 cfs (1 April- May).

(3). Control to 105,000 cfs at Spalding insofar as possible without going below 4,000-cfs discharge until reservoir fills to within 140,000 acre-feet of full (5 May-24 May).

(4). Maintain 140,000 acre-feet of space until inflows recede below 30,000 cfs (24 May-31 May) to protect against late runoff.

(5). Fill the remaining space as soon as possible using 4,000-cfs release after inflows recede below 30,000 cfs (31 May-4 June). The standard project flood at Spalding was reduced from a peak of 260,000 cfs to 150,000 cfs by this regulation.

d. Probable Maximum Flood. The probable maximum flood inflow was approved by the Office, Chief of Engineers, on 18 December 1968. For reference, see the 6th endorsement of that date to a letter from NPW to NPD, dated 4 June 1968, subject: Review of the Probable Maximum Flood, Dworshak Project, Idaho. The probable maximum flood was based on an extremely critical sequence of flood-producing conditions. At the beginning of the high runoff season, the assumed water content of the basin snowpack was 63.3 inches as compared to less than 30 inches maximum for past years of knowledge. For +63.3 inches depth of water in snow, forecast studies indicate that the 1 May to 31 July runoff would be at least 56 inches depth of water for the drainage area, or 7.3 million acre-feet. Volumes of other flood seasons for comparison are 4.4 million acre-feet for the spring standard project flood, 3.2 and 3.1 million acre-feet for the two largest flood seasons of record, and 2 million acre-feet for the average of 42 seasons of record.

The factors used for development of the probable maximum flood, together with space requirements for flood control versus forecasted runoff volumes, would both require and permit full evacuation of the reservoir storage prior to the flood season. Flood season runoff over about 3 million acre-feet indicate 2 million acre-feet of reservoir capacity for their regulation. For these reasons, Dworshak Reservoir would be at minimum pool at the beginning of the probable maximum flood.

In the definite project studies for Dworshak Project, the amount of flood control space needed in the reservoir was based on the effective control of floods up to magnitude of standard project flood. However, in those studies it was apparent that with this storage space, considerable regulation of rain flood peaks could be accomplished for floods in excess of the standard project flood. This is so because rain flood volumes are relatively small in contrast to the large volume from snowmelt runoff which persists for extended periods. For floods in excess of standard project flood magnitude, the criterion adopted for flood regulation is reservation of the maximum practicable amount of space in Dworshak Reservoir for reduction of rain flood peaks whenever the 1 May to 31 July forecasted runoff exceeds 125 % of the standard project flood, or 5.5 million acre-feet.

Regulation of the probable maximum flood requires making maximum capacity releases throughout the flood until rule curves for snow covered area, shown in step 4 below, indicate that storage space may be filled. Plate 8-2 illustrates the resulting regulation of the probable maximum flood. Description of procedures follows:

(1). On 1 May, the reservoir is at minimum pool with 2 million acre-feet of space available. Forecasted runoff is 7.3 million acre-feet. Rule curves require maximum capacity releases.

(2). From 1 May to 24 May, capacity releases made include full use of the outlet works plus three-fourths of turbine capacity.

(3). From 24 May through the probable maximum rainstorm runoff, capacity releases made include full use of the spillway, the outlet, and three-fourths of turbine capacity until total discharges equal 100,000 cfs. For discharges greater than 100,000 cfs, capacities of the spillway and outlets only are used since the powerhouse may be subject to flooding from flows overtopping the spillway chute.

Model studies indicate that overtopping of the tailrace deck (elevation 1,005) should not occur for total discharges up to 135,000 cfs and with six powerhouse units in operation. Average tailwater elevations at the powerhouse are shown on Plate 2-8 for 0, 5,000, 11,000, and 29,000 cfs through the powerhouse and for total discharges of 0 to 220,000 cfs. These studies verified that the stilling basin was adequate for spillway discharges up to 45,000 cfs and a powerhouse discharge of 5,000 cfs. Under existing conditions, a maximum average tailwater elevation of 997 occurred with a powerhouse discharge of 11,000 cfs (Units 1 to 3) and a total discharge of 80,000 cfs. Fluctuations in tailwater levels increase with spillway flows above 45,000 cfs due to instabilities in flow patterns and resultant wave action. For details on model studies, refer to Hydraulic Model Investigation, Technical Report No. 116-1, Dworshak Dam - North Fork Clearwater River, Idaho, dated September 1984.

(4). As inflow recedes, regulate releases to store water in accordance with the rule curve shown below:

| Percent of Area Covered by Accumulated Winter Snowpack | Space Reservation 1,000 A.F. |
|---|---|
| 100 | 700 |
| 80 | 540 |
| 60 | 385 |
| 40 | 230 |
| 20 | 80 |
| 10 | 0 |

The probable maximum flood regulation results in a maximum release of 220,000 cfs, maximum storage of 3,556,000 acre-feet, and a maximum pool elevation of 1,604.7 feet. Outlet capacity for this condition is 40,000 cfs, leaving 180,000 cfs to be passed through the spillway.

e. Flood Frequency

(1). Clearwater River. Frequency data was computed for the following key gauging stations:

(a). North Fork Clearwater River at Dworshak Dam, Idaho.

(b). Clearwater River at Spalding, Idaho.

Unregulated and regulated frequency curves are shown on Plate 8-3.1 for the North Fork Clearwater near Ahsahka, Idaho, and on Plate 8-3.2 for the Clearwater River at Spalding, Idaho. Frequency curve data from Plate 8-3.1 and Plate 8-3.2 are summarized in the following tabulation:

| ANNUAL MAXIMUM MEAN DAILY PEAK DISCHARGE FREQUENCIES | | | | | |
|---|---|---|---|---|---|
| | | North Fork Clearwater at Dworshak | | Clearwater River at Spalding | |
| **Exceedence Probability (Percent)** | **Average Recurrence Interval (Years)** | **Unregulated Discharge (cfs)** | **Regulated Discharge (cfs)** | **Unregulated Discharge (cfs)** | **Regulated Discharge (cfs)** |
| Standard Project Flood | | 160,000 | 75,000 | 280,000 | 150,000 |
| 1 | 100 | 73,000 | 40,000 | 198,000 | 130,000 |
| 2 | 50 | 65,500 | 36,200 | 180,000 | 125,000 |
| 5 | 20 | 55,500 | 31,800 | 157,000 | 117,000 |
| 10 | 10 | 48,000 | 28,900 | 139,000 | 112,000 |
| 20 | 5 | 40,700 | 26,100 | 119,500 | 105,000 |
| 50 | 2 | 29,600 | 19,300 | 89,500 | 89,500 |

Plate 8-3.3 and Plate 8-3.4 show regulated summary hydrographs, and Table 8-1 and Table 8-2 list regulated monthly runoff volumes for the North Fork Clearwater River at Dworshak Dam and the Clearwater River at Spalding.

(2). Snake River at Lower Granite. Plate 8-4 shows frequency curves for natural peak discharges and regulated peak discharges for the Snake River at Lower Granite Dam. These frequencies were computed by NPDEN-WM-HES in May 1978. The frequency curve for natural discharges is based on the station record from 1894 to 1975 (81 years) which is adjusted for irrigation depletion and storage and extended by correlation with 1858 to 1975 (117 years) Columbia River at The Dalles station record. The frequency curve for regulated discharge is based on 1975 level of storage development and 1985 level of irrigation depletions. Regulated discharges are from regulation studies for 1894, 1929 through 1958, and in addition are high runoff years of 1972 and 1974. Data from Plate 8-4, Snake River at Lower Granite Frequency Curves, are summarized in the following tabulation:

| ANNUAL MAXIMUM MEAN DAILY PEAK DISCHARGE FREQUENCIES | | | |
|---|---|---|---|
| **Average Exceedence Probability (Percent)** | **Recurrence Interval (Years)** | **Unregulated Discharge (cfs)** | **Regulated Discharge (cfs)** |
| Standard Project Flood | | 575,000 | 420,000 |
| 1 | 100 | 426,000 | 319,000 |
| 2 | 50 | 403,000 | 300,000 |
| 5 | 20 | 367,000 | 270,000 |
| 10 | 10 | 334,000 | 244,000 |
| 20 | 5 | 298,000 | 214,000 |
| 50 | 2 | 231,000 | 163,000 |

f. Power. Another benefit credited to the project is effective in controlling floods on the lower Clearwater River and the lower Snake River.

8-03 Recreation.

Recreation opportunities in the region of Dworshak Reservoir have been greatly improved since the dam was built. The reservoir provides a large lake suitable for boating, water skiing, and swimming. Several boat launching sites and beaches have made this a popular recreation area. Travel by boat to the upper levels of the reservoir has allowed access to areas that were formerly not served by even primitive roads. Because the rugged wilderness terrain is desirable for hunting, camping, and picnicking, this access has generated a great increase in public use of the area.

The following tabulation summarizes the effects of drawdown, below full pool (elevation 1,600), on reservoir use, recreation, and wildlife. In addition, Table 2-6 lists Dworshak's public recreation sites and corresponding operational elevations.

| Drawdown | Effects |
|---|---|
| 5-10 feet (El. 1,590-1,595) | Bass catch reduced. Swimming adversely affected. Shoreline to water distance increased; steep slopes cause ten mini-camp sites to be unusable. Increase in turbidity due to waves. 10-20 % reduction in visitation. |
| 10-15 feet (El. 1,585-1,590) | Heavy turbidity due to wave action. Troublesome backing distance for boat launching. 40 mini-camp sites unusable. 30 % reduction in visitation. Bass spawning seriously affected; overall productivity seriously reduced. Trout and kokanee spawning affected. |
| 15-25 feet (El. 1,575-1,585) | Fishing access impaired. Animals traveling to water more visible and vulnerable to hunters. 50 % reduction in visitation. Reservoir production for kokanee seriously reduced. Log dumps become unusable. |
| 25-50 feet (El. 1,550-1,575) | 75 % reduction in visitation. Boat ramps extremely difficult to use or unusable. Water temperature greatly reduced. Severely reduced fisherman access. All mini-camps without road access unusable. Hunter access by boat restricted. Reservoir trout productivity seriously reduced. |

NOTE: Drawdowns below elevation 1,550 make all boat launching sites unusable (except Bruces Eddy) and eliminates almost all other recreation uses.

Source: Draft, Position Paper on Reservoir Refill-Advance Energy, USCE-NPD, dated 11 May 1978.

8-04 Water Quality.

Because of selector gates in the dam which allow discharge of water from selective levels of the reservoir, it is possible to regulate the temperature of water discharged from the North Fork Clearwater. This is ideal for the Federal fish hatchery located just below the dam, which requires 53-degree water. The selector gates are used to supply this water temperature when possible.

It is also possible to regulate water temperature and quality to affect the water quality of rivers and reservoirs downstream, especially during low water years. Special operation for this has not been done to date.

8-05 Fish and Wildlife.

Dworshak Reservoir has been stocked with both trout and salmon and has become a major sport fishery. There is also a large bass population which has produced a state record smallmouth bass.

Releasing water from the dam in summer months that is cooler than natural stream flow has changed the main stem Clearwater River into a prime cold water trout fishery. This has been at the expense of the bass population, which has decreased.

Increased releases from Dworshak may be required during the juvenile outmigration period to augment the flows in Snake River. These increased flows, along with better passage facilities at downstream dams, will result in greater survival of outmigrating fish. Juvenile mortality is increased during the low flow periods due to longer travel times through the reservoirs. Mortalities result from predators and failure to reach the ocean while they can still adapt to salt water. However, these augmented flows may require Dworshak to release water in amounts greater than can be used for power generation, either at site or downstream projects. It is impossible at this time to determine what the exact effect on Dworshak FELCC will be, but studies indicate the loss to the entire Columbia River Basin generation system to meet combined fish flow requirements at Lower Granite Dam on the Snake River and Priest Rapids Dam on the Columbia will be about 550 MW in firm energy load carrying capability.

# 9 WATER CONTROL MANAGEMENT

9-01 Responsibilities and Organization.

The complex system of reservoirs in the Columbia River Basin and their diverse ownership requires a high degree of cooperation and coordination between Federal, state, municipal, and other public and private organizations which have interests in the reservoir regulation activities of the Columbia River system. Dworshak is a part of this system.

a. Corps of Engineers. In general, the North Pacific Division (NPD) Reservoir Control Center (RCC) plans and directs the regulation of NPD reservoirs and certain non-Corps reservoirs that have space allocated for flood control. The RCC coordinates the regulation of NPD, non-Corps, and Canadian reservoirs in the Columbia River Basin in order to increase the effectiveness of the system operation under routine and critical conditions.

The real-time daily regulation of Dworshak Reservoir is the direct responsibility of the NPD RCC. For special reservoir operations, the RCC collaborates with the Hydrology Branch of the Walla Walla District. The Hydrology Branch provides assistance and support to the RCC by participating in reservoir regulation studies, computing long-range runoff volume forecasts, supplying hydrometeorological data, and providing reservoir regulation manuals for District projects. Final regulation plans are approved and administered by the RCC. Physical operation and maintenance of the Dworshak Project is the responsibility of the project manager.

Emergency_Procedures, in the front of the manual, shows organizational charts and corresponding personnel names and telephone numbers pertinent to the operation of Dworshak for the North Pacific Division and Walla Walla District, Corps of Engineers.

b. Other Federal Agencies

(1). The National Weather Service. Northwest River Forecast Center (RFD) is authorized to issue coordinated runoff volume forecasts, peak flow forecasts, and flood stage forecasts for key gauging stations within the Columbia River Basin. See Section VII of this Manual for details on hydrologic forecasts. A formal agreement in 1963 between the Corps of Engineers and NWS formed the Cooperative Columbia River Forecasting Service. In 1971, this agreement was amended to include Bonneville Power Administration. A three-member technical committee provides technical advice and guidance to the Columbia River Forecasting Service. The three committee members are as follows:

Chief, Hydrologic Engineering Section, NPD
Chief, National Weather Service, Portland RFC
Chief, Hydrometeorology Branch, Bonneville Power Administration

(2). Bonneville Power Administration (BPA). The BPA is the marketing agency for electric power produced at existing and future Federal hydroelectric projects throughout the Columbia River Basin system. This group of Federal hydroelectric plants, along with BPA's transmission facilities, is known as the Federal Columbia River Power System. Dworshak is a unit of this system. The Chief of the Corps of Engineers North Pacific Division, Reservoir Control Center (RCC) coordinates with BPA's Chief of Division of Power Supply and Chief of Power Scheduling Branch on significant regulation decisions that affect power generation. Routine power scheduling is accomplished by NPD RCC in coordination with BPA's Power Scheduling Branch. BPA dispatchers coordinate power production from the Federal projects on a real-time basis.

A Memorandum of Understanding, entered into on 8 October 1956 and revised on 16 November 1970, between the NPD and the BPA documents the policies and procedures to be followed in the operation of the Corps of Engineers projects. The objective of this Memorandum of Understanding is to maximize power generation by coordinated operations within the normal and special operating limits of NPD projects.

(3). Other Agencies. Other agencies with which the RCC coordinates and exchanges information in the process of carrying out reservoir regulation activities include the Bureau of Reclamation, USGS, SCS, Federal Energy Regulatory Commission, Federal and state fish and wildlife agencies, Federal and state water quality agencies, non-Federal public utilities, private power utilities, and navigation interests.

Details on coordination of reservoir regulation activities with other agencies on a system basis are provided in the RCC Guidance Memorandum dated January 1972 and the Master Regulation Manual for the Columbia River Basin to be prepared in the near future.

c. State and County Agencies

d. Private Organization.

9-02 Interagency Coordination.

The principal organizations which have been formed to coordinate the planning and operation of the Columbia River system projects are the Northwest Power Pool, the Pacific Northwest Coordination Contract Committee, the Columbia River Treaty Operating Committee, and the Columbia River Water Management Group.

a. Northwest Power Pool. The Northwest Power Pool is a voluntary organization whose primary function is to coordinate the operation and maintenance of the power systems of the Pacific Northwest. It also serves as a coordinating group for the solution of a variety of system operating problems. The membership of the Northwest Power Pool includes 20 utilities and agencies as follows:

1. Bonneville Power Administration
2. Bureau of Reclamation
3. British Columbia Hydro and Power Authority
4. Chelan County PUD
5. Corps of Engineers
6. Douglas County PUD
7. Eugene Water and Electric Board
8. Grant County PUD
9. Idaho Power Company
10. Montana Power Company
11. Pacific Power and Light Company
12. Portland General Electric Company
13. Puget Sound Power and Light Company
14. Seattle City Light
15. Sierra Pacific Company
16. Tacoma City Light
17. Transalta Utilities Corporation
18. Utah Power and Light Company
19. Washington Water Power
20. West Kootenay Power and Light Company

The functions of the pool are carried out by means of an Operating Committee and a Coordinating Group.

(1). Operating Committee. The Operating Committee consists of one member from each participating system through whom all pool matters are handled. Implementation of any pool action requires unanimous approval by the Operating Committee. The Operating Committee has three continuous subcommittees: Relaying, Communications, and Maintenance.

(2). Coordinating Group. The Coordinating Group, headquartered in Portland, Oregon, consists of four full-time engineers and their necessary clerical help. It acts as a staff for the Operating Committee and the Coordination Contract Committee of the Pacific Northwest Coordination Agreement and provides a clearinghouse for all pool utilities. The group initiates telephone conference calls, chairs Operating Committee meetings, prepares numerous load-resource analyses, takes a lead in coordinating operating with the pool and with adjacent areas, and makes other operating studies and reports. A considerable amount of time is spent on making load-resource analyses for both the Coordinated System of the Pacific Northwest Coordination Agreement and the Northwest Power Pool. Utilizing digital computers, these analyses are made from load and resource data supplied by the utilities. The Northwest Power Pool does not maintain a centralized group to schedule and dispatch the combined resources of the members of the pool. Rather, each member system remains autonomous, scheduling and dispatching its own resources to serve its own load. The Northwest Power Pool is a member of the North American Power Systems Interconnection Committee (NAPSIC) which coordinates energy interchange between ten regional systems.

b. Pacific Northwest Coordination Agreement. The utilities of the Pacific Northwest have long recognized the need for coordinated operation. Through the years, the Northwest Power Pool and other inter-utilities arrangements have accomplished much toward this end. These efforts culminated in the Pacific Northwest Coordination Agreement, a formal contract for coordinating the seasonal operation of the generating resources of the member systems for the best utilization of their collective reservoir storage. Finalized in mid-August 1964, the agreement (Contract No. 14-02-4822) became effective on 4 January 1965 and terminates on 30 June 2003. The following 18 agencies and utilities have ratified the agreement:

1. Bonneville Power Administration
2. Bureau of Reclamation
3. Corps of Engineers
4. Chelan County PUD
5. Colockum Transmission Company
6. Cowlitz County PUD
7. Douglas County PUD
8. Eugene Water and Electric Board
9. Grant County PUD
10. Montana Power Company
11. Pacific Power and Light Company
12. Pend Oreille PUD
13. Portland General Electric Company
14. Puget Sound Power and Light Company
15. Seattle City Light
16. Snohomish County PUD
17. Tacoma City Light
18. Washington Water Power Company

A fundamental concept of the Coordination Agreement is “Firm Load Carrying Capability,” commonly abbreviated as FLCC. For the coordinated system of all 18 parties, the FLCC is the aggregate firm load that the system could carry under coordinated operation with critical period stream flow conditions and with the use of all reservoir storage.

In order to accomplish such coordinated operation, the combined power facilities of the parties are operated to produce optimum firm load-carrying ability.

Each party is entitled to a Firm Energy Load Carrying Capability (FELCC) equal to its capability in the critical stream flow period with full upstream storage release, except for reimbursement of Canadian treaty benefits and restoration of capability to parties which suffer loss in critical period energy capability as a result of the Canadian treaty storage. FELCC’s are sustained by exchange of energy between parties.

Prior to the start of a contract year, a reservoir operating and storage schedule is developed to provide the optimum FELCC of the coordinated system. This schedule is melded with a schedule that provides adequate assurance of reservoir refill. The resulting schedule, called an Energy Content Curve (ECC), is used in the operation of the system to determine system generation. Generation in excess of FELCC resulting from draft to ECC is used to serve secondary load. If draft below ECC is required to carry FELCC, then secondary load is not served.

The above discussion refers primarily to the procedures followed to insure meeting FELCC during periods of critical stream flow. However, the same basic procedures are used to insure optimum utilization of reservoir storage during years of plentiful stream flow as well.

Representatives of the participants in the agreement are members of the Coordination Contract Committee. This committee makes studies and analyses and rules on any actions concerning the agreement. Most of its work is delegated to the Northwest Power Pool Coordinating Group. However, some of the work is delegated to one or more of the participants. If as may frequently happen, the best operation for the coordinated system requires a utility to cut back on releases and to hold storage for later use, thereby reducing its present generation below its FELCC and perhaps below its load requirements, it has the right to call for and receive interchange energy from a party with excess capability. Later, when the first party's storage is scheduled for release, it will be able to return the energy. Provision is made to pay for any imbalances in such interchange energy exchange accounts that may remain at the end of a contract year.

The agreement provides that, upon request, a utility is entitled to the energy that it could generate at its plants if upstream reservoirs released all water above their ECU's. The upstream party can either release the water or, if it has surplus energy and wishes to conserve its storage for later use, it may deliver energy "in lieu" of the water. The upstream party is not required to spill water to satisfy demands of a downstream utility.

Other provisions of the agreement include the following: (1) each party shall accept for storage in available reservoir space energy surplus to other parties' needs; (2) equitable compensation shall be made for the benefits from reservoir storage; (3) the obligation to reimburse treaty power to Canada shall be shared by the projects which benefit from treaty storage in proportion to their benefits; (4) interconnecting transmission facilities shall be made available for coordination use subject to the owners' prior requirements; and (5) equitable charges shall be made for capacity, energy, transmission, storage, and other services. Nothing in the agreement is intended to conflict with project constraints for other functions such as flood control, recreation, fish, irrigation, etc.

c. Columbia River Treaty. In 1964, the Columbia River Treaty for the international development of the Columbia River was ratified by the governments of Canada and the United States. The treaty provided for Canada to build and operate three reservoirs presently known as Duncan Lake, Arrow Lake, and Kinbasket Lake. These three reservoirs have a combined usable storage of 20.5 million acre-feet. Under the treaty, Canada operates these reservoirs in a manner which increases downstream power generation and reduces flood damage in the United States. In return for the benefits received, the United States gives Canada half of the dependable capacity and half the energy gain in the United States as a result of Canadian storage and pays Canada an amount equal to half the value of flood damages prevented.

In carrying out the functions required under the Columbia River Treaty, each country has set up a working organization. The treating working organization is comprised of a permanent engineering board, U.S. and Canadian entities, U.S. coordinators, Manager - Canadian Entity Service, and two international committees. The RCC Guidance Memorandum dated January 1972 provides details on functions and responsibilities of these working organizations.

d. Columbia River Water Management Group. The Columbia River Water Management Group acts as a committee to consider problems relating to operation and management of water control facilities in the Columbia River Basin. Upon review and discussion of the problems, the group makes tentative recommendations for consideration of the individual agencies having primary responsibilities in these areas. The basic function of the group is coordination of river systems operations, including the efficient operation of the hydrometeorological system required for each operation. The Water Management Group prepares an annual report which summarizes hydrometeorological and reservoir regulation activities and activities and accomplishments of member agencies as related to the Columbia River and tributaries. The membership of the Columbia River Management Group is composed of representatives from the following state and Federal agencies:

1. Bureau of Reclamation
2. Bonneville Power Administration
3. Corps of Engineers
4. National Weather Service
5. United States Geological Survey
6. Environmental Protection Agency - Water Quality Office
7. U.S. Forest Service
8. Soil Conservation Service
9. Bureau of Land Management
10. Federal Energy Regulatory Commission
11. Fish and Wildlife Service
12. National Marine Fisheries Service
13. Oregon Water Resources Department
14. Washington Department of Ecology
15. Idaho Department of Ecology
16. Nevada State Engineer
17. Department of Natural Resources and Conservation (Montana)
18. Wyoming State Engineer

9-03 Interagency Agreements.

9-04 Commissions, River Authorities, Compacts and Committees.

9-05 Non-Federal Hydropower.

9-06 Reports.

Public Notices. Special reservoir regulation activities, which may not be considered normal reservoir regulation activities, will be required from time to time. Reservoir regulation plans for special activities would still be developed within the normal operating limits and constraints of the Dworshak Project. Public notices will be issued only when the special reservoir operations that are scheduled or anticipated will be of concern to public activities. Public notices pertaining to Dworshak Project will be issued by the Operations Division of the Walla Walla District.

The list of agencies and individuals to notify should include, but not necessarily be limited to: Dworshak Fish Hatchery, Idaho Fish and Game Department, Idaho Department of Water Resources, Potlatch Forest Industries, City of Orofino, City of Lewiston, City of Clarkston, newspapers, and television and radio stations for Orofino, Lewiston, and Clarkston.

Reservoir regulation news releases to newspapers, radio stations, and television stations will be coordinated by the Walla Walla District's Hydrology Branch with the North Pacific Division's Reservoir Control Center and issued by the Public Affairs Officer of the Walla Walla District.

Regulation Decisions and Records. The North Pacific Division's Reservoir Control Center is responsible for making regulation decisions which affect project discharge rates and storage for flood control, power generation, and special operations. The goal of the RCC is to effectively and efficiently schedule Dworshak Project operations in order to maximize benefits for project purposes. A daily log noting pertinent conversations and discussions leading to regulation decisions will be kept current both at the project and the RCC. Details and completeness of the daily log will be as necessary for after-the-fact review and analysis of regulation plans. Regulation decisions and instructions are discussed with appropriate project personnel and confirmed on the Columbia Basin Teletype system (CBT).

# TABLES

No.

# TABLE 2-1

DWORSHAK DAM SPILLWAY RATING
SINGLE BAY DISCHARGE IN CFS
(Based on 2 Bay Operation)

| Water Surface Elevation (FMSL) | Nominal Gate Opening In Feet | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1605 | 2180 | 4140 | 6100 | 8075 | 10050 | 12075 | 14100 | 15767 | 17433 | 19100 | 21160 | 23220 | 25280 |
| 1600 | 2000 | 3890 | 5781 | 7684 | 9587 | 11460 | 13333 | 15079 | 16825 | 18571 | 20408 | 22244 | 24080 |
| 1595 | 1850 | 3678 | 5507 | 7243 | 8979 | 10773 | 12567 | 14231 | 15896 | 17561 | 19253 | 20945 | 22637 |
| 1590 | 1700 | 3470 | 5241 | 6843 | 8455 | 10127 | 11800 | 13383 | 14967 | 16550 | 18107 | 19664 | 21221 |
| 1585 | 1600 | 3264 | 4928 | 6448 | 7969 | 9472 | 10975 | 12470 | 13964 | 15549 | 16883 | 18308 | 19732 |
| 1580 | 1500 | 3046 | 4591 | 5989 | 7387 | 8768 | 10150 | 11493 | 12836 | 14179 | 15486 | 16793 | 18100 |
| 1575 | 1400 | 2823 | 4246 | 5485 | 6724 | 7968 | 9213 | 10434 | 11655 | 12877 | 14020 | 15162 | 16305 |
| 1570 | 1300 | 2593 | 3886 | 4973 | 6061 | 7168 | 8275 | 9331 | 10387 | 11443 | 12420 | 13397 | 14374 |
| 1565 | 1190 | 2345 | 3500 | 4449 | 5398 | 6368 | 7338 | 8175 | 9012 | 9849 | 10741 | 11632 | 12524 |
| 1560 | 1080 | 2016 | 2953 | 3728 | 4502 | 5382 | 6261 | 6944 | * | * | * | * | * |
| 1555 | 1000 | 1681 | 2362 | 2969 | 3576 | * | * | * | | | | | |
| 1550 | 600 | 1151 | * | * | * | | | | | | | | |
| 1549 | 566 | 1117 | * | | | | | | | | | | |
| 1548 | 531 | * | | | | | | | | | | | |
| 1547 | * | | | | | | | | | | | | |
| 1546 | * | | | | | | | | | | | | |
| 1545 | 0 | | | | | | | | | | | | |

NOTES:
1. Data Source: Reservoir Regulation Manual - Project Rating Tables, U.S. Army Corps of Engineers, Walla Walla District, May 1973.
2. Top spillway crest elevation 1545.
3. * - Refer to Plate 3-3.2, Spillway Rating Curves.

## TABLE 2-1 continued

DWORSHAK DAM SPILLWAY RATING
SINGLE BAY DISCHARGE IN CFS
(Based on Two Bay Operation)

| Water Surface Elevation (FMSL) | Nominal Gate Opening In Feet 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1605 | 40780 | 42560 | 44340 | 46120 | 47900 | 49570 | 51240 | 52910 | 54580 | 56250 | 58000 | 59750 | 61500 |
| 1600 | 38286 | 39923 | 41560 | 43198 | 44835 | 46452 | 48069 | 49686 | 51303 | 52919 | 54521 | 56123 | 57725 |
| 1595 | 35845 | 37370 | 38895 | 40420 | 41945 | 43442 | 44939 | 46436 | 47933 | 49430 | 50989 | 52548 | 54107 |
| 1590 | 33202 | 34607 | 36012 | 37417 | 38822 | 40280 | 41737 | 43195 | 44652 | 46110 | 47706 | 49303 | * |
| 1585 | 30558 | 31867 | 33176 | 34485 | 35794 | 37232 | 38670 | 40109 | * | * | * | * | |
| 1580 | 27895 | 29144 | 30393 | 31642 | * | * | * | * | | | | | |
| 1575 | * | * | * | * | | | | | | | | | |
| 1570 | * | | | | | | | | | | | | |
| 1565 | * | | | | | | | | | | | | |
| 1560 | * | | | | | | | | | | | | |
| 1555 | * | | | | | | | | | | | | |
| 1550 | * | | | | | | | | | | | | |
| 1549 | * | | | | | | | | | | | | |
| 1548 | * | | | | | | | | | | | | |
| 1547 | * | | | | | | | | | | | | |
| 1547 | * | | | | | | | | | | | | |
| 1545 | 0 | | | | | | | | | | | | |

NOTES:
1. Data Source, Reservoir Regulation Manual - Project Rating Tables, U.S. Army Corps of Engineers, Walla Walla District, May 1973.
2. Top spillway crest elevation 1545.
3. * - Refer to Plate 3-3.2, Spillway Rating Curves.

## TABLE 2-2

DWORSHAK DAM - SINGLE OUTLET DISCHARGE IN 1000 CFS

| GATE OPENING IN FEET | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 | 10.5 | 11.0 | 11.5 | 12.0 | 12.5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| REVOLUTION COUNTER READING | 314 | 468 | 623 | 769 | 909 | 1059 | 1200 | 1335 | 1470 | 1686 | 1740 | 1870 | 2002 | 2125 | 2252 | 2377 | 2499 | 2621 | 2740 | 2861 | 2976 | 3093 | 3208 | 3323 | 3432 |
| SET POINT | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| POOL ELEV. | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1605 | 0.5 | 1.0 | 1.4 | 1.8 | 2.2 | 2.6 | 3.0 | 3.4 | 3.8 | 4.2 | 4.6 | 5.0 | 5.5 | 5.9 | 6.4 | 6.8 | 7.3 | 7.9 | 8.5 | 9.2 | 9.9 | 10.7 | 11.6 | 12.5 | 13.4 |
| 1600 | 0.5 | 0.9 | 1.4 | 1.8 | 2.2 | 2.6 | 3.0 | 3.3 | 3.7 | 4.2 | 4.6 | 5.0 | 5.4 | 5.8 | 6.3 | 6.8 | 7.3 | 7.8 | 8.4 | 9.1 | 9.8 | 10.6 | 11.4 | 12.4 | 13.3 |
| 1595 | 0.5 | 0.9 | 1.3 | 1.7 | 2.1 | 2.5 | 2.9 | 3.3 | 3.7 | 4.1 | 4.5 | 4.9 | 5.3 | 5.8 | 6.2 | 6.7 | 7.2 | 7.7 | 8.3 | 8.9 | 9.6 | 10.4 | 11.3 | 12.2 | 13.1 |
| 1590 | 0.5 | 0.9 | 1.3 | 1.7 | 2.1 | 2.5 | 2.9 | 3.3 | 3.7 | 4.1 | 4.5 | 4.9 | 5.3 | 5.7 | 6.1 | 6.6 | 7.1 | 7.6 | 8.2 | 8.8 | 9.5 | 10.3 | 11.1 | 12.1 | 13.0 |
| 1585 | 0.5 | 0.9 | 1.3 | 1.7 | 2.1 | 2.5 | 2.9 | 3.2 | 3.6 | 4.0 | 4.4 | 4.8 | 5.2 | 5.6 | 6.1 | 6.5 | 7.0 | 7.5 | 8.1 | 8.7 | 9.4 | 10.2 | 11.0 | 11.9 | 12.8 |
| 1580 | 0.5 | 0.9 | 1.3 | 1.7 | 2.1 | 2.5 | 2.8 | 3.2 | 3.6 | 4.0 | 4.4 | 4.8 | 5.2 | 5.6 | 6.0 | 6.5 | 6.9 | 7.4 | 8.0 | 8.6 | 9.3 | 10.0 | 10.8 | 11.7 | 12.7 |
| 1575 | 0.5 | 0.9 | 1.3 | 1.7 | 2.0 | 2.4 | 2.8 | 3.2 | 3.5 | 3.9 | 4.3 | 4.7 | 5.1 | 5.5 | 5.9 | 6.4 | 6.8 | 7.3 | 7.9 | 8.5 | 9.1 | 9.9 | 10.7 | 11.6 | 12.5 |
| 1570 | 0.5 | 0.9 | 1.3 | 1.6 | 2.0 | 2.4 | 2.7 | 3.1 | 3.5 | 3.9 | 4.3 | 4.6 | 5.0 | 5.4 | 5.8 | 6.3 | 6.7 | 7.2 | 7.8 | 8.4 | 9.0 | 9.7 | 10.5 | 11.4 | 12.4 |
| 1565 | 0.5 | 0.9 | 1.3 | 1.6 | 2.0 | 2.4 | 2.7 | 3.1 | 3.5 | 3.8 | 4.2 | 4.6 | 5.0 | 5.4 | 5.8 | 6.2 | 6.6 | 7.1 | 7.7 | 8.3 | 8.9 | 9.6 | 10.4 | 11.3 | 12.2 |
| 1560 | 0.5 | 0.9 | 1.2 | 1.6 | 2.0 | 2.3 | 2.7 | 3.1 | 3.4 | 3.8 | 4.1 | 4.5 | 4.9 | 5.3 | 5.7 | 6.1 | 6.6 | 7.0 | 7.6 | 8.1 | 8.7 | 9.4 | 10.2 | 11.1 | 12.1 |
| 1555 | 0.5 | 0.8 | 1.2 | 1.6 | 1.9 | 2.3 | 2.7 | 3.0 | 3.4 | 3.7 | 4.1 | 4.5 | 4.8 | 5.2 | 5.6 | 6.0 | 6.5 | 6.9 | 7.5 | 8.0 | 8.6 | 9.3 | 10.1 | 11.0 | 11.9 |
| 1550 | 0.4 | 0.8 | 1.2 | 1.6 | 1.9 | 2.3 | 2.6 | 3.0 | 3.4 | 3.7 | 4.0 | 4.4 | 4.8 | 5.2 | 5.5 | 6.0 | 6.4 | 6.9 | 7.4 | 7.9 | 8.5 | 9.2 | 9.9 | 10.8 | 11.7 |
| 1545 | 0.4 | 0.8 | 1.2 | 1.5 | 1.9 | 2.2 | 2.6 | 3.0 | 3.3 | 3.6 | 4.0 | 4.4 | 4.7 | 5.1 | 5.5 | 5.9 | 6.3 | 6.8 | 7.2 | 7.8 | 8.3 | 9.0 | 9.7 | 10.7 | 11.6 |
| 1540 | 0.4 | 0.8 | 1.2 | 1.5 | 1.9 | 2.2 | 2.6 | 2.9 | 3.3 | 3.6 | 3.9 | 4.3 | 4.7 | 5.0 | 5.4 | 5.8 | 6.2 | 6.7 | 7.1 | 7.7 | 8.2 | 8.9 | 9.6 | 10.5 | 11.4 |
| 1535 | 0.4 | 0.8 | 1.1 | 1.5 | 1.8 | 2.2 | 2.5 | 2.9 | 3.2 | 3.6 | 3.9 | 4.2 | 4.6 | 4.9 | 5.3 | 5.7 | 6.1 | 6.6 | 7.0 | 7.5 | 8.1 | 8.7 | 9.4 | 10.4 | 11.3 |
| 1530 | 0.4 | 0.8 | 1.1 | 1.5 | 1.8 | 2.2 | 2.5 | 2.8 | 3.2 | 3.5 | 3.8 | 4.2 | 4.5 | 4.9 | 5.2 | 5.6 | 6.0 | 6.5 | 6.9 | 7.4 | 7.9 | 8.6 | 9.3 | 10.2 | 11.1 |
| 1525 | 0.4 | 0.8 | 1.1 | 1.4 | 1.8 | 2.1 | 2.5 | 2.8 | 3.1 | 3.5 | 3.8 | 4.1 | 4.5 | 4.8 | 5.2 | 5.5 | 5.9 | 6.4 | 6.8 | 7.3 | 7.8 | 8.4 | 9.1 | 10.0 | 10.9 |
| 1520 | 0.4 | 0.8 | 1.1 | 1.4 | 1.8 | 2.1 | 2.4 | 2.7 | 3.1 | 3.4 | 3.7 | 4.1 | 4.4 | 4.7 | 5.1 | 5.5 | 5.8 | 6.3 | 6.7 | 7.2 | 7.7 | 8.3 | 9.0 | 9.9 | 10.8 |
| 1515 | 0.4 | 0.8 | 1.1 | 1.4 | 1.7 | 2.1 | 2.4 | 2.7 | 3.0 | 3.4 | 3.7 | 4.0 | 4.3 | 4.7 | 5.0 | 5.4 | 5.7 | 6.2 | 6.6 | 7.1 | 7.5 | 8.2 | 8.8 | 9.7 | 10.6 |
| 1510 | 0.4 | 0.7 | 1.1 | 1.4 | 1.7 | 2.0 | 2.3 | 2.7 | 3.0 | 3.3 | 3.6 | 3.9 | 4.3 | 4.6 | 4.9 | 5.3 | 5.6 | 6.1 | 6.5 | 6.9 | 7.4 | 8.0 | 8.7 | 9.5 | 10.4 |
| 1505 | 0.4 | 0.7 | 1.1 | 1.4 | 1.7 | 2.0 | 2.3 | 2.6 | 2.9 | 3.2 | 3.5 | 3.9 | 4.2 | 4.5 | 4.8 | 5.2 | 5.6 | 6.0 | 6.4 | 6.8 | 7.3 | 7.9 | 8.5 | 9.4 | 10.2 |
| 1500 | 0.4 | 0.7 | 1.0 | 1.3 | 1.7 | 2.0 | 2.3 | 2.6 | 2.9 | 3.2 | 3.5 | 3.8 | 4.1 | 4.4 | 4.8 | 5.1 | 5.5 | 5.9 | 6.3 | 6.7 | 7.1 | 7.7 | 8.3 | 9.2 | 10.0 |
| 1495 | 0.4 | 0.7 | 1.0 | 1.3 | 1.6 | 1.9 | 2.2 | 2.5 | 2.8 | 3.1 | 3.4 | 3.7 | 4.0 | 4.3 | 4.7 | 5.0 | 5.4 | 5.8 | 6.1 | 6.6 | 7.0 | 7.6 | 8.2 | 9.0 | 9.8 |
| 1490 | 0.4 | 0.7 | 1.0 | 1.3 | 1.6 | 1.9 | 2.2 | 2.5 | 2.8 | 3.1 | 3.4 | 3.7 | 4.0 | 4.3 | 4.6 | 4.9 | 5.3 | 5.6 | 6.0 | 6.4 | 6.9 | 7.4 | 8.0 | 8.9 | 9.7 |
| 1485 | 0.3 | 0.7 | 1.0 | 1.3 | 1.6 | 1.9 | 2.1 | 2.4 | 2.7 | 3.0 | 3.3 | 3.6 | 3.9 | 4.2 | 4.5 | 4.8 | 5.2 | 5.5 | 5.9 | 6.3 | 6.7 | 7.3 | 7.9 | 8.7 | 9.5 |
| 1480 | 0.3 | 0.7 | 1.0 | 1.2 | 1.6 | 1.8 | 2.1 | 2.4 | 2.7 | 3.0 | 3.2 | 3.5 | 3.8 | 4.1 | 4.4 | 4.7 | 5.1 | 5.4 | 5.8 | 6.2 | 6.6 | 7.1 | 7.7 | 8.5 | 9.3 |
| 1475 | 0.3 | 0.7 | 0.9 | 1.2 | 1.5 | 1.8 | 2.1 | 2.3 | 2.6 | 2.9 | 3.2 | 3.5 | 3.7 | 4.0 | 4.3 | 4.6 | 5.0 | 5.3 | 5.7 | 6.1 | 6.5 | 7.0 | 7.5 | 8.3 | 9.1 |
| 1470 | 0.3 | 0.6 | 0.9 | 1.2 | 1.5 | 1.7 | 2.0 | 2.3 | 2.6 | 2.8 | 3.1 | 3.4 | 3.7 | 3.9 | 4.2 | 4.5 | 4.9 | 5.2 | 5.5 | 5.9 | 6.3 | 6.8 | 7.4 | 8.2 | 8.8 |
| 1465 | 0.3 | 0.6 | 0.9 | 1.2 | 1.5 | 1.7 | 2.0 | 2.2 | 2.5 | 2.8 | 3.0 | 3.3 | 3.6 | 3.9 | 4.1 | 4.4 | 4.7 | 5.1 | 5.4 | 5.8 | 6.2 | 6.7 | 7.2 | 8.0 | 8.6 |
| 1460 | 0.3 | 0.6 | 0.9 | 1.2 | 1.4 | 1.7 | 1.9 | 2.2 | 2.5 | 2.7 | 3.0 | 3.2 | 3.5 | 3.8 | 4.0 | 4.3 | 4.6 | 5.0 | 5.3 | 5.7 | 6.0 | 6.5 | 7.1 | 7.8 | 8.4 |
| 1455 | 0.3 | 0.6 | 0.9 | 1.1 | 1.4 | 1.6 | 1.9 | 2.1 | 2.4 | 2.6 | 2.9 | 3.2 | 3.4 | 3.7 | 3.9 | 4.2 | 4.5 | 4.9 | 5.2 | 5.5 | 5.9 | 6.4 | 6.9 | 7.6 | 8.2 |
| 1450 | 0.3 | 0.6 | 0.8 | 1.1 | 1.4 | 1.6 | 1.8 | 2.1 | 2.3 | 2.6 | 2.8 | 3.1 | 3.3 | 3.6 | 3.8 | 4.1 | 4.4 | 4.7 | 5.1 | 5.4 | 5.8 | 6.2 | 6.7 | 7.4 | 8.0 |
| 1445 | 0.3 | 0.6 | 0.8 | 1.1 | 1.3 | 1.6 | 1.8 | 2.0 | 2.3 | 2.5 | 2.8 | 3.0 | 3.2 | 3.5 | 3.8 | 4.0 | 4.3 | 4.6 | 4.9 | 5.3 | 5.6 | 6.0 | 6.5 | 7.2 | 7.7 |

Source: Project Rating Tables - Appendix A, TABLE A-3 (DWORSHAK - SINGLE OUTLET DISCHARGE), U.S. Army Corps of Engineers, Walla Walla District, May 1973, Revised April 1986 by NPW Hydrology Branch.

# TABLE 2-3

Dworshak Dam and Reservoir
POWER UNIT DISCHARGE RATING TABLE
DISCHARGE IN CFS
90 MW UNIT

| Gross Head Ft. | Generator Output MW 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 455 | 995 | 1120 | 1240 | 1370 | 1490 | 1645 | 1775 | 1925 | 2080 | 2310 | | |
| 460 | 980 | 1105 | 1225 | 1350 | 1470 | 1615 | 1750 | 1895 | 2045 | 2245 | 2460 | |
| 465 | 965 | 1090 | 1210 | 1335 | 1455 | 1595 | 1725 | 1865 | 2015 | 2190 | 2375 | 2695 |
| 470 | 955 | 1075 | 1190 | 1320 | 1440 | 1575 | 1705 | 1835 | 1980 | 2140 | 2310 | 2590 |
| 475 | 940 | 1060 | 1175 | 1305 | 1425 | 1555 | 1685 | 1810 | 1955 | 2100 | 2255 | 2490 |
| 480 | 935 | 1045 | 1160 | 1290 | 1410 | 1535 | 1665 | 1785 | 1930 | 2060 | 2210 | 2415 |
| 485 | 920 | 1035 | 1150 | 1280 | 1400 | 1520 | 1650 | 1765 | 1910 | 2030 | 2170 | 2355 |
| 490 | 915 | 1025 | 1135 | 1265 | 1385 | 1505 | 1630 | 1745 | 1885 | 2000 | 2130 | 2300 |
| 495 | 905 | 1015 | 1125 | 1255 | 1370 | 1490 | 1615 | 1730 | 1860 | 1980 | 2105 | 2255 |
| 500 | 900 | 1005 | 1115 | 1245 | 1360 | 1480 | 1600 | 1710 | 1840 | 1955 | 2075 | 2210 |
| 505 | 890 | 995 | 1105 | 1235 | 1350 | 1465 | 1590 | 1695 | 1820 | 1935 | 2050 | 2175 |
| 510 | 885 | 990 | 1095 | 1225 | 1340 | 1450 | 1570 | 1680 | 1805 | 1915 | 2030 | 2145 |
| 515 | 875 | 980 | 1090 | 1215 | 1330 | 1440 | 1560 | 1665 | 1790 | 1900 | 2010 | 2120 |
| 520 | 870 | 970 | 1080 | 1205 | 1320 | 1430 | 1545 | 1650 | 1770 | 1880 | 1990 | 2095 |
| 525 | 865 | 965 | 1075 | 1200 | 1310 | 1420 | 1540 | 1635 | 1750 | 1865 | 1975 | 2070 |
| 530 | 860 | 960 | 1065 | 1190 | 1300 | 1410 | 1525 | 1620 | 1735 | 1845 | 1955 | 2050 |
| 535 | 855 | 950 | 1060 | 1180 | 1295 | 1400 | 1515 | 1610 | 1725 | 1830 | 1940 | 2035 |
| 540 | 850 | 945 | 1055 | 1175 | 1285 | 1390 | 1505 | 1600 | 1710 | 1820 | 1930 | 2015 |
| 545 | 845 | 940 | 1050 | 1165 | 1280 | 1380 | 1490 | 1590 | 1695 | 1800 | 1915 | 2000 |
| 550 | 840 | 935 | 1040 | 1160 | 1270 | 1370 | 1480 | 1575 | 1685 | 1790 | 1900 | 1980 |
| 555 | 835 | 930 | 1040 | 1150 | 1260 | 1360 | 1470 | 1565 | 1670 | 1775 | 1885 | 1965 |
| 560 | 830 | 925 | 1035 | 1140 | 1250 | 1350 | 1460 | 1555 | 1660 | 1760 | 1870 | 1955 |
| 565 | 825 | 920 | 1030 | 1135 | 1245 | 1340 | 1450 | 1545 | 1650 | 1750 | 1860 | 1940 |
| 570 | 820 | 915 | 1025 | 1130 | 1240 | 1330 | 1440 | 1535 | 1635 | 1735 | 1845 | 1925 |
| 575 | 820 | 910 | 1020 | 1120 | 1230 | 1320 | 1425 | 1525 | 1625 | 1720 | 1830 | 1915 |
| 580 | 810 | 910 | 1015 | 1115 | 1220 | 1315 | 1415 | 1515 | 1610 | 1710 | 1815 | 1900 |
| 585 | 810 | 900 | 1010 | 1110 | 1210 | 1305 | 1405 | 1505 | 1600 | 1700 | 1800 | 1890 |
| 590 | 805 | 900 | 1005 | 1100 | 1205 | 1295 | 1395 | 1495 | 1590 | 1685 | 1790 | 1875 |
| 595 | 800 | 895 | 1000 | 1095 | 1200 | 1290 | 1385 | 1485 | 1580 | 1675 | 1770 | 1860 |
| 600 | 795 | 890 | 990 | 1090 | 1190 | 1280 | 1375 | 1475 | 1570 | 1665 | 1760 | 1850 |
| 605 | 790 | 885 | 990 | 1080 | 1180 | 1270 | 1365 | 1465 | 1555 | 1655 | 1745 | 1840 |
| 610 | 790 | 880 | 980 | 1075 | 1170 | 1260 | 1355 | 1455 | 1545 | 1645 | 1730 | 1825 |
| 615 | 780 | 880 | 980 | 1070 | 1165 | 1250 | 1345 | 1445 | 1540 | 1635 | 1725 | 1815 |
| 620 | 780 | 875 | 970 | 1060 | 1155 | 1240 | 1335 | 1435 | 1530 | 1625 | 1715 | 1805 |
| 625 | 775 | 870 | 965 | 1055 | 1150 | 1235 | 1330 | 1425 | 1520 | 1615 | 1710 | 1795 |
| 630 | 770 | 870 | 960 | 1050 | 1140 | 1230 | 1320 | 1415 | 1515 | 1605 | 1700 | 1780 |

TABLE 2-3
# TABLE 2-3 (Continued)

Dworshak Dam and Reservoir
POWER UNIT DISCHARGE RATING TABLE
DISCHARGE IN CFS
90 MW UNIT

| Gross Head Ft. | Generator Output MW 90 | 95 | 100 | 105 | 110 | 115 | 120 | 125 | 130 | 135 | 140 | 145 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 465 | | | | | | | | | | | | |
| 470 | | | | | | | | | | | | |
| 475 | | | | | | | | | | | | |
| 480 | 2680 | | | | | | | | | | | |
| 485 | 2575 | 2905 | | | | | | | | | | |
| 490 | 2490 | 2780 | | | | | | | | | | |
| 495 | 2420 | 2670 | | | | | | | | | | |
| 500 | 2365 | 2595 | 2890 | | | | | | | | | |
| 505 | 2320 | 2525 | 2770 | | | | | | | | | |
| 510 | 2280 | 2470 | 2680 | 3020 | | | | | | | | |
| 515 | 2250 | 2420 | 2600 | 2910 | | | | | | | | |
| 520 | 2220 | 2380 | 2540 | 2800 | | | | | | | | |
| 525 | 2200 | 2340 | 2490 | 2720 | 2995 | | | | | | | |
| 530 | 2175 | 2310 | 2450 | 2655 | 2880 | | | | | | | |
| 535 | 2160 | 2280 | 2415 | 2595 | 2795 | | | | | | | |
| 540 | 2140 | 2255 | 2380 | 2550 | 2720 | 3045 | | | | | | |
| 545 | 2120 | 2235 | 2355 | 2510 | 2665 | 2955 | | | | | | |
| 550 | 2105 | 2215 | 2330 | 2475 | 2620 | 2880 | | | | | | |
| 555 | 2085 | 2190 | 2305 | 2445 | 2580 | 2810 | 3080 | | | | | |
| 560 | 2065 | 2170 | 2280 | 2415 | 2550 | 2755 | 3000 | | | | | |
| 565 | 2050 | 2150 | 2260 | 2390 | 2520 | 2705 | 2930 | | | | | |
| 570 | 2030 | 2135 | 2240 | 2365 | 2490 | 2655 | 2865 | 3115 | | | | |
| 575 | 2015 | 2115 | 2220 | 2340 | 2460 | 2620 | 2810 | 3035 | | | | |
| 580 | 2000 | 2100 | 2200 | 2320 | 2440 | 2585 | 2755 | 2965 | 3210 | | | |
| 585 | 1980 | 2085 | 2180 | 2300 | 2415 | 2560 | 2710 | 2900 | 3125 | | | |
| 590 | 1965 | 2070 | 2165 | 2280 | 2395 | 2530 | 2670 | 2850 | 3045 | 3255 | | |
| 595 | 1955 | 2055 | 2150 | 2260 | 2375 | 2505 | 2635 | 2800 | 2980 | 3165 | | |
| 600 | 1940 | 2040 | 2135 | 2245 | 2360 | 2485 | 2610 | 2750 | 2920 | 3090 | 3245 | |
| 605 | 1930 | 2030 | 2125 | 2230 | 2340 | 2460 | 2575 | 2715 | 2870 | 3020 | 3165 | |
| 610 | 1920 | 2020 | 2115 | 2220 | 2320 | 2440 | 2550 | 2680 | 2820 | 2965 | 3095 | 3325 |
| 615 | 1905 | 2010 | 2100 | 2205 | 2305 | 2420 | 2530 | 2650 | 2780 | 2920 | 3040 | 3235 |
| 620 | 1895 | 2000 | 2090 | 2190 | 2290 | 2405 | 2510 | 2620 | 2745 | 2875 | 2995 | 3170 |
| 625 | 1890 | 1990 | 2085 | 2180 | 2280 | 2385 | 2490 | 2595 | 2720 | 2840 | 2955 | 3115 |
| 630 | 1880 | 1980 | 2080 | 2165 | 2270 | 2370 | 2470 | 2570 | 2690 | 2810 | 2920 | 3070 |

Dworshak Dam and Reservoir
POWER UNIT DISCHARGE RATING TABLE
DISCHARGE IN CFS
220 MW UNIT

| Gross Head Ft. | Generator Output MW 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 | 105 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 457 | 1760 | 1885 | 2020 | 2125 | 2250 | 2388 | 2505 | 2640 | 2765 | 2900 | 3030 | 3155 |
| 460 | 1750 | 1875 | 2000 | 2120 | 2240 | 2370 | 2495 | 2615 | 2750 | 2880 | 3005 | 3130 |
| 465 | 1735 | 1855 | 1980 | 2100 | 2215 | 2350 | 2470 | 2590 | 2725 | 2850 | 2970 | 3100 |
| 470 | 1720 | 1835 | 1960 | 2080 | 2195 | 2330 | 2440 | 2560 | 2685 | 2815 | 2935 | 3060 |
| 475 | 1700 | 1820 | 1940 | 2060 | 2170 | 2300 | 2415 | 2535 | 2665 | 2785 | 2900 | 3030 |
| 480 | 1675 | 1800 | 1920 | 2030 | 2150 | 2280 | 2400 | 2520 | 2640 | 2760 | 2870 | 3000 |
| 485 | 1665 | 1790 | 1900 | 2020 | 2135 | 2260 | 2370 | 2495 | 2615 | 2735 | 2845 | 2970 |
| 490 | 1660 | 1780 | 1885 | 2000 | 2115 | 2250 | 2350 | 2470 | 2590 | 2715 | 2820 | 2945 |
| 495 | 1650 | 1765 | 1870 | 1980 | 2100 | 2230 | 2330 | 2450 | 2570 | 2685 | 2790 | 2920 |
| 500 | 1640 | 1755 | 1855 | 1970 | 2085 | 2210 | 2315 | 2430 | 2550 | 2665 | 2770 | 2905 |
| 505 | 1625 | 1735 | 1840 | 1950 | 2070 | 2200 | 2300 | 2415 | 2530 | 2645 | 2750 | 2875 |
| 510 | 1615 | 1730 | 1830 | 1935 | 2055 | 2180 | 2280 | 2400 | 2515 | 2620 | 2725 | 2850 |
| 515 | 1605 | 1715 | 1825 | 1925 | 2045 | 2165 | 2265 | 2380 | 2500 | 2600 | 2700 | 2830 |
| 520 | 1600 | 1710 | 1820 | 1915 | 2030 | 2150 | 2250 | 2375 | 2480 | 2590 | 2690 | 2815 |
| 525 | 1590 | 1700 | 1800 | 1895 | 2020 | 2135 | 2240 | 2350 | 2465 | 2570 | 2670 | 2790 |
| 530 | 1585 | 1680 | 1790 | 1880 | 2005 | 2120 | 2225 | 2335 | 2445 | 2555 | 2650 | 2770 |
| 535 | 1570 | 1675 | 1780 | 1870 | 1995 | 2110 | 2210 | 2325 | 2430 | 2540 | 2635 | 2755 |
| 540 | 1560 | 1670 | 1770 | 1860 | 1980 | 2090 | 2195 | 2310 | 2420 | 2525 | 2620 | 2735 |
| 545 | 1555 | 1655 | 1760 | 1850 | 1970 | 2080 | 2185 | 2295 | 2400 | 2510 | 2600 | 2715 |
| 550 | 1550 | 1650 | 1755 | 1840 | 1960 | 2070 | 2170 | 2275 | 2380 | 2490 | 2580 | 2700 |
| 555 | 1540 | 1635 | 1750 | 1830 | 1950 | 2055 | 2160 | 2270 | 2370 | 2480 | 2570 | 2680 |
| 560 | 1530 | 1630 | 1735 | 1820 | 1940 | 2045 | 2150 | 2255 | 2355 | 2460 | 2560 | 2665 |
| 565 | 1525 | 1615 | 1730 | 1810 | 1925 | 2045 | 2145 | 2240 | 2340 | 2450 | 2540 | 2650 |
| 570 | 1515 | 1610 | 1720 | 1800 | 1915 | 2020 | 2125 | 2230 | 2330 | 2435 | 2525 | 2630 |
| 575 | 1510 | 1600 | 1710 | 1795 | 1905 | 2010 | 2110 | 2215 | 2310 | 2420 | 2510 | 2610 |
| 580 | 1500 | 1595 | 1695 | 1790 | 1895 | 2000 | 2095 | 2200 | 2295 | 2410 | 2490 | 2600 |
| 585 | 1490 | 1590 | 1695 | 1780 | 1890 | 1995 | 2090 | 2195 | 2275 | 2395 | 2480 | 2580 |
| 590 | 1480 | 1580 | 1685 | 1775 | 1880 | 1980 | 2075 | 2180 | 2260 | 2380 | 2465 | 2560 |
| 595 | 1470 | 1565 | 1675 | 1765 | 1870 | 1970 | 2060 | 2160 | 2245 | 2365 | 2450 | 2550 |
| 600 | 1465 | 1560 | 1665 | 1760 | 1855 | 1960 | 2050 | 2150 | 2235 | 2350 | 2430 | 2520 |
| 605 | 1455 | 1555 | 1660 | 1750 | 1850 | 1950 | 2040 | 2140 | 2215 | 2340 | 2425 | 2515 |
| 610 | 1450 | 1550 | 1650 | 1745 | 1845 | 1945 | 2030 | 2130 | 2205 | 2325 | 2410 | 2500 |
| 615 | 1445 | 1545 | 1640 | 1740 | 1835 | 1930 | 2020 | 2115 | 2195 | 2315 | 2400 | 2485 |
| 620 | 1440 | 1540 | 1640 | 1730 | 1825 | 1920 | 2010 | 2100 | 2185 | 2300 | 2385 | 2475 |
| 625 | 1435 | 1535 | 1635 | 1725 | 1820 | 1915 | 2000 | 2095 | 2180 | 2290 | 2375 | 2465 |
| 630 | 1425 | 1530 | 1625 | 1720 | 1810 | 1910 | 1995 | 2085 | 2175 | 2280 | 2370 | 2455 |

Dworshak Dam and Reservoir
POWER UNIT DISCHARGE RATING TABLE
DISCHARGE IN CFS
220 MW UNIT

| Gross Head Ft. | Generator Output MW 110 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 457 | 3270 | 3390 | 3515 | 3640 | 3775 | 3900 | 4020 | 4145 | 4275 | 4420 | 4550 | 4690 |
| 460 | 3245 | 3370 | 3495 | 3615 | 3750 | 3870 | 4000 | 4125 | 4250 | 4385 | 4520 | 4670 |
| 465 | 3210 | 3335 | 3460 | 3580 | 3705 | 3830 | 3955 | 4080 | 4200 | 4335 | 4465 | 4610 |
| 470 | 3170 | 3300 | 3425 | 3545 | 3665 | 3785 | 3915 | 4035 | 4155 | 4290 | 4420 | 4560 |
| 475 | 3135 | 3275 | 3395 | 3510 | 3630 | 3750 | 3875 | 3990 | 4115 | 4245 | 4375 | 4510 |
| 480 | 3100 | 3240 | 3365 | 3475 | 3600 | 3720 | 3830 | 3950 | 4070 | 4200 | 4340 | 4465 |
| 485 | 3070 | 3215 | 3335 | 3450 | 3560 | 3685 | 3800 | 3910 | 4035 | 4160 | 4285 | 4415 |
| 490 | 3050 | 3180 | 3305 | 3420 | 3530 | 3655 | 3770 | 3875 | 4000 | 4120 | 4245 | 4370 |
| 495 | 3020 | 3155 | 3280 | 3385 | 3500 | 3620 | 3735 | 3840 | 3965 | 4085 | 4200 | 4330 |
| 500 | 3000 | 3130 | 3250 | 3360 | 3475 | 3595 | 3700 | 3810 | 3940 | 4050 | 4170 | 4280 |
| 505 | 2970 | 3110 | 3230 | 3335 | 3445 | 3565 | 3675 | 3775 | 3900 | 4015 | 4135 | 4250 |
| 510 | 2950 | 3080 | 3200 | 3305 | 3415 | 3535 | 3650 | 3750 | 3870 | 3980 | 4100 | 4215 |
| 515 | 2930 | 3060 | 3175 | 3280 | 3390 | 3510 | 3625 | 3725 | 3840 | 3950 | 4065 | 4170 |
| 520 | 2910 | 3040 | 3150 | 3255 | 3365 | 3490 | 3600 | 3695 | 3815 | 3915 | 4040 | 4130 |
| 525 | 2885 | 3015 | 3125 | 3235 | 3340 | 3460 | 3570 | 3670 | 3780 | 3890 | 4000 | 4105 |
| 530 | 2865 | 3000 | 3100 | 3210 | 3320 | 3435 | 3550 | 3645 | 3750 | 3860 | 3970 | 4070 |
| 535 | 2850 | 2975 | 3075 | 3185 | 3300 | 3410 | 3520 | 3620 | 3725 | 3835 | 3940 | 4035 |
| 540 | 2825 | 2950 | 3045 | 3160 | 3275 | 3385 | 3500 | 3590 | 3700 | 3800 | 3910 | 4000 |
| 545 | 2810 | 2930 | 3035 | 3140 | 3250 | 3365 | 3470 | 3570 | 3670 | 3775 | 3880 | 3975 |
| 550 | 2790 | 2910 | 3010 | 3120 | 3230 | 3340 | 3440 | 3540 | 3645 | 3750 | 3850 | 3950 |
| 555 | 2770 | 2890 | 2995 | 3090 | 3210 | 3315 | 3420 | 3520 | 3620 | 3720 | 3825 | 3920 |
| 560 | 2760 | 2870 | 2975 | 3075 | 3185 | 3300 | 3400 | 3495 | 3600 | 3695 | 3800 | 3900 |
| 565 | 2745 | 2850 | 2955 | 3050 | 3170 | 3275 | 3365 | 3465 | 3570 | 3660 | 3770 | 3870 |
| 570 | 2720 | 2835 | 2940 | 3035 | 3150 | 3250 | 3345 | 3440 | 3550 | 3640 | 3745 | 3835 |
| 575 | 2700 | 2810 | 2915 | 3010 | 3125 | 3220 | 3315 | 3415 | 3520 | 3615 | 3720 | 3805 |
| 580 | 2690 | 2790 | 2900 | 3000 | 3105 | 3200 | 3300 | 3395 | 3500 | 3585 | 3682 | 3780 |
| 585 | 2670 | 2770 | 2880 | 2975 | 3085 | 3175 | 3270 | 3365 | 3475 | 3565 | 3665 | 3755 |
| 590 | 2650 | 2750 | 2860 | 2960 | 3060 | 3155 | 3245 | 3340 | 3450 | 3540 | 3645 | 3730 |
| 595 | 2635 | 2730 | 2845 | 2940 | 3040 | 3135 | 3225 | 3320 | 3430 | 3515 | 3620 | 3705 |
| 600 | 2620 | 2720 | 2820 | 2920 | 3015 | 3110 | 3200 | 3300 | 3405 | 3500 | 3600 | 3685 |
| 605 | 2600 | 2700 | 2810 | 2905 | 3000 | 3100 | 3180 | 3280 | 3380 | 3475 | 3580 | 3665 |
| 610 | 2585 | 2685 | 2795 | 2890 | 2980 | 3075 | 3165 | 3260 | 3360 | 3450 | 3555 | 3630 |
| 615 | 2575 | 2670 | 2775 | 2870 | 2965 | 3055 | 3150 | 3245 | 3345 | 3430 | 3535 | 3615 |
| 620 | 2565 | 2660 | 2760 | 2860 | 2950 | 3040 | 3130 | 3230 | 3330 | 3410 | 3515 | 3595 |
| 625 | 2550 | 2650 | 2750 | 2845 | 2930 | 3025 | 3120 | 3210 | 3310 | 3400 | 3495 | 3575 |
| 630 | 2550 | 2630 | 2740 | 2825 | 2915 | 3005 | 3115 | 3190 | 3300 | 3380 | 3470 | 3560 |

# TABLE 2-4

Dworshak Dam and Reservoir
POWER UNIT DISCHARGE RATING TABLE
DISCHARGE IN CFS
220 MW UNIT

| Gross Head Ft. | Generator Output MW 170 | 175 | 180 | 185 | 190 | 195 | 200 | 205 | 210 | 215 | 220 | 225 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 457 | 4825 | 5000 | 5180 | 5400 | 5660 | | | | | | | |
| 460 | 4795 | 4955 | 5130 | 5330 | 5555 | 5850 | | | | | | |
| 465 | 4730 | 4885 | 5060 | 5220 | 5410 | 5640 | 5925 | | | | | |
| 470 | 4675 | 4820 | 4980 | 5130 | 5290 | 5490 | 5710 | 5980 | | | | |
| 475 | 4620 | 4750 | 4910 | 5050 | 5190 | 5365 | 5570 | 5770 | 6080 | | | |
| 480 | 4570 | 4700 | 4840 | 4975 | 5100 | 5270 | 5450 | 5625 | 5850 | 6150 | | |
| 485 | 4525 | 4650 | 4790 | 4920 | 5040 | 5185 | 5335 | 5510 | 5700 | 5925 | 6200 | |
| 490 | 4475 | 4600 | 4730 | 4860 | 4970 | 5115 | 5255 | 5410 | 5575 | 5765 | 5980 | 6250 |
| 495 | 4435 | 4540 | 4680 | 4805 | 4910 | 5050 | 5180 | 5330 | 5480 | 5645 | 5835 | 6035 |
| 500 | 4400 | 4505 | 4630 | 4750 | 4860 | 4985 | 5120 | 5260 | 5400 | 5540 | 5710 | 5875 |
| 505 | 4360 | 4470 | 4580 | 4710 | 4815 | 4935 | 5055 | 5190 | 5320 | 5460 | 5610 | 5760 |
| 510 | 4430 | 4430 | 4535 | 4665 | 4765 | 4885 | 5000 | 5125 | 5250 | 5380 | 5530 | 5665 |
| 515 | 4280 | 4400 | 4495 | 4620 | 4725 | 4840 | 4955 | 5075 | 5195 | 5315 | 5460 | 5580 |
| 520 | 4250 | 4360 | 4455 | 4580 | 4680 | 4800 | 4900 | 5020 | 5130 | 5250 | 5390 | 5500 |
| 525 | 4220 | 4320 | 4415 | 4550 | 4650 | 4755 | 4860 | 4980 | 5080 | 5190 | 5325 | 5440 |
| 530 | 4185 | 4290 | 4380 | 4515 | 4615 | 4720 | 4820 | 4935 | 5035 | 5140 | 5270 | 5380 |
| 535 | 4150 | 4255 | 4350 | 4475 | 4575 | 4680 | 4785 | 4895 | 4995 | 5095 | 5220 | 5330 |
| 540 | 4115 | 4225 | 4320 | 4440 | 4550 | 4655 | 4750 | 4855 | 4960 | 5050 | 5175 | 5275 |
| 545 | 4090 | 4195 | 4280 | 4405 | 4505 | 4605 | 4715 | 4815 | 4905 | 5005 | 5130 | 5230 |
| 550 | 4060 | 4165 | 4255 | 4375 | 4475 | 4575 | 4680 | 4780 | 4870 | 4970 | 5080 | 5185 |
| 555 | 4025 | 4130 | 4225 | 4340 | 4440 | 4550 | 4650 | 4745 | 4835 | 4935 | 5050 | 5145 |
| 560 | 4000 | 4100 | 4200 | 4320 | 4420 | 4520 | 4620 | 4720 | 4800 | 4900 | 5010 | 5100 |
| 565 | 3970 | 4080 | 4170 | 4280 | 4380 | 4485 | 4580 | 4680 | 4765 | 4860 | 4975 | 5070 |
| 570 | 3940 | 4050 | 4145 | 4255 | 4350 | 4455 | 4550 | 4650 | 4730 | 4830 | 4940 | 5030 |
| 575 | 3915 | 4020 | 4120 | 4230 | 4315 | 4425 | 4520 | 4620 | 4700 | 4800 | 4905 | 5000 |
| 580 | 3890 | 4000 | 4080 | 4200 | 4290 | 4400 | 4490 | 4595 | 4680 | 4770 | 4880 | 4970 |
| 585 | 3865 | 3970 | 4065 | 4170 | 4260 | 4365 | 4460 | 4560 | 4645 | 4740 | 4845 | 4930 |
| 590 | 3840 | 3945 | 4040 | 4150 | 4235 | 4340 | 4430 | 4530 | 4620 | 4710 | 4815 | 4900 |
| 595 | 3810 | 3915 | 4015 | 4120 | 4200 | 4310 | 4400 | 4500 | 4585 | 4680 | 4785 | 4880 |
| 600 | 3790 | 3880 | 3990 | 4080 | 4180 | 4270 | 4375 | 4460 | 4560 | 4660 | 4750 | 4850 |
| 605 | 3765 | 3860 | 3960 | 4060 | 4150 | 4255 | 4345 | 4440 | 4530 | 4625 | 4725 | 4820 |
| 610 | 3740 | 3840 | 3940 | 4040 | 4125 | 4225 | 4320 | 4410 | 4500 | 4600 | 4700 | 4790 |
| 615 | 3720 | 3815 | 3915 | 4015 | 4100 | 4200 | 4290 | 4385 | 4480 | 4575 | 4675 | 4760 |
| 620 | 3700 | 3795 | 3895 | 3985 | 4075 | 4175 | 4265 | 4360 | 4450 | 4550 | 4650 | 4735 |
| 625 | 3670 | 3765 | 3865 | 3960 | 4040 | 4150 | 4240 | 4335 | 4430 | 4525 | 4620 | 4710 |
| 630 | 3650 | 3740 | 3830 | 3940 | 4020 | 4120 | 4210 | 4300 | 4400 | 4500 | 4600 | 4680 |

Dworshak Dam and Reservoir
POWER UNIT DISCHARGE RATING TABLE
DISCHARGE IN CFS
220 MW UNIT

| Gross Head Ft. | Generator Output MW 230 | 235 | 240 | 245 | 250 | 255 | 260 | 265 | 270 | 275 | 280 | 285 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 457 | | | | | | | | | | | | |
| 460 | | | | | | | | | | | | |
| 465 | | | | | | | | | | | | |
| 470 | | | | | | | | | | | | |
| 475 | | | | | | | | | | | | |
| 480 | | | | | | | | | | | | |
| 485 | | | | | | | | | | | | |
| 490 | | | | | | | | | | | | |
| 495 | 6250 | | | | | | | | | | | |
| 500 | 6100 | 6320 | | | | | | | | | | |
| 505 | 5940 | 6150 | 6400 | | | | | | | | | |
| 510 | 5830 | 6015 | 6230 | | | | | | | | | |
| 515 | 5735 | 5905 | 6095 | 6300 | | | | | | | | |
| 520 | 5650 | 5810 | 5980 | 6150 | 6375 | | | | | | | |
| 525 | 5580 | 5730 | 5900 | 6040 | 6230 | 6450 | | | | | | |
| 530 | 5520 | 5660 | 5825 | 5950 | 6120 | 6310 | 6525 | | | | | |
| 535 | 5455 | 5600 | 5750 | 5875 | 6025 | 6190 | 6375 | 6600 | | | | |
| 540 | 5425 | 5530 | 5670 | 5800 | 5930 | 6100 | 6250 | 6430 | 6630 | | | |
| 545 | 5350 | 5480 | 5620 | 5750 | 5870 | 6010 | 6155 | 6330 | 6515 | 6725 | | |
| 550 | 5305 | 5435 | 5570 | 5690 | 5805 | 5940 | 6075 | 6240 | 6420 | 6595 | 6800 | |
| 555 | 5260 | 5385 | 5515 | 5635 | 5745 | 5875 | 6000 | 6150 | 6320 | 6480 | 6670 | 6830 |
| 560 | 5240 | 5350 | 5470 | 5595 | 5700 | 5840 | 5975 | 6100 | 6250 | 6400 | 6560 | 6720 |
| 565 | 5180 | 5295 | 5420 | 5535 | 5640 | 5760 | 5870 | 6010 | 6160 | 6300 | 6465 | 6600 |
| 570 | 5140 | 5255 | 5375 | 5490 | 5595 | 5710 | 5815 | 5950 | 6090 | 6225 | 6375 | 6510 |
| 575 | 5110 | 5220 | 5330 | 5445 | 5550 | 5660 | 5760 | 5890 | 6020 | 6150 | 6290 | 6425 |
| 580 | 5090 | 5180 | 5290 | 5400 | 5500 | 5620 | 5725 | 5840 | 5960 | 6080 | 6230 | 6350 |
| 585 | 5035 | 5150 | 5250 | 5360 | 5460 | 5570 | 5670 | 5785 | 5900 | 6020 | 6145 | 6280 |
| 590 | 5005 | 5115 | 5220 | 5325 | 5425 | 5530 | 5625 | 5735 | 5840 | 5960 | 6070 | 6215 |
| 595 | 4975 | 5080 | 5180 | 5285 | 5390 | 5495 | 5580 | 5690 | 5785 | 5900 | 6020 | 6160 |
| 600 | 4940 | 5040 | 5130 | 5230 | 5330 | 5435 | 5530 | 5630 | 5740 | 5850 | 5960 | 6080 |
| 605 | 4915 | 5020 | 5113 | 5210 | 5310 | 5420 | 5500 | 5600 | 5700 | 5805 | 5910 | 6055 |
| 610 | 4885 | 4995 | 5080 | 5180 | 5275 | 5385 | 5465 | 5570 | 5660 | 5770 | 5865 | 6005 |
| 615 | 4855 | 4960 | 5050 | 5140 | 5245 | 5350 | 5430 | 5530 | 5630 | 5730 | 5830 | 5960 |
| 620 | 4830 | 4930 | 5020 | 5110 | 5210 | 5320 | 5400 | 5500 | 5590 | 5700 | 5795 | 5915 |
| 625 | 4800 | 4900 | 4980 | 5080 | 5180 | 5290 | 5360 | 5470 | 5560 | 5660 | 5755 | 5870 |
| 630 | 4770 | 4870 | 4960 | 5050 | 5150 | 5260 | 5330 | 5430 | 5525 | 5630 | 5730 | 5825 |

Dworshak Dam and Reservoir
POWER UNIT DISCHARGE RATING TABLE
DISCHARGE IN CFS
220 MW UNIT

| Gross Head Ft. | Generator Output MW 290 | 295 | 300 | 305 | 310 | 315 | 320 | 325 | 330 | 335 | 340 | 345 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 457 | | | | | | | | | | | | |
| 460 | | | | | | | | | | | | |
| 465 | | | | | | | | | | | | |
| 470 | | | | | | | | | | | | |
| 475 | | | | | | | | | | | | |
| 480 | | | | | | | | | | | | |
| 485 | | | | | | | | | | | | |
| 490 | | | | | | | | | | | | |
| 495 | | | | | | | | | | | | |
| 500 | | | | | | | | | | | | |
| 505 | | | | | | | | | | | | |
| 510 | | | | | | | | | | | | |
| 515 | | | | | | | | | | | | |
| 520 | | | | | | | | | | | | |
| 525 | | | | | | | | | | | | |
| 530 | | | | | | | | | | | | |
| 535 | | | | | | | | | | | | |
| 540 | | | | | | | | | | | | |
| 545 | | | | | | | | | | | | |
| 550 | | | | | | | | | | | | |
| 555 | | | | | | | | | | | | |
| 560 | 6900 | | | | | | | | | | | |
| 565 | 6790 | 6950 | | | | | | | | | | |
| 570 | 6680 | 6830 | 7025 | | | | | | | | | |
| 575 | 6575 | 6725 | 6900 | 7075 | | | | | | | | |
| 580 | 6500 | 6640 | 6790 | 6940 | 7120 | | | | | | | |
| 585 | 6415 | 6540 | 6690 | 6840 | 7000 | 7160 | | | | | | |
| 590 | 6335 | 6455 | 6590 | 6740 | 6895 | 7045 | 7220 | | | | | |
| 595 | 6280 | 6385 | 6515 | 6650 | 6800 | 6950 | 7105 | 7260 | | | | |
| 600 | 6200 | 6320 | 6440 | 6580 | 6720 | 6860 | 7010 | 7160 | | | | |
| 605 | 6155 | 6255 | 6370 | 6490 | 6630 | 6770 | 6925 | 7070 | 7250 | | | |
| 610 | 6105 | 6205 | 6310 | 6430 | 6570 | 6700 | 6850 | 6980 | 7150 | 7290 | | |
| 615 | 6060 | 6160 | 6260 | 6375 | 6510 | 6630 | 6775 | 6910 | 7060 | 7200 | 7350 | |
| 620 | 6020 | 6110 | 6215 | 6325 | 6460 | 6575 | 6710 | 6840 | 6980 | 7120 | 7265 | 7425 |
| 625 | 5975 | 6070 | 6175 | 6285 | 6415 | 6525 | 6650 | 6775 | 6910 | 7045 | 7180 | 7320 |
| 630 | 5930 | 6030 | 6140 | 6250 | 6370 | 6480 | 6600 | 6720 | 6840 | 6970 | 7100 | 7230 |

TABLE 2-5

13340950 DWORSHAK RESERVOIR NEAR AHSAHKA, IDAHO
STORAGE CAPACITY IN 1,000 ACRE-FEET

| Elevation (feet) | Gross Storage | Usable Storage | Space Available | Area (acres) |
|---|---|---|---|---|
| 1445.0 | 1452.2 | 0.0 | 2015.8 | 9047 |
| .5 | 1456.8 | 4.8 | 2011.2 | |
| 1446.0 | 1461.3 | 9.3 | 2006.7 | 9086 |
| .5 | 1465.8 | 13.8 | 2002.2 | |
| 1447.0 | 1470.4 | 18.4 | 1997.6 | 9125 |
| .5 | 1474.9 | 22.9 | 1993.1 | |
| 1448.0 | 1479.4 | 27.4 | 1988.6 | 9165 |
| .5 | 1484.0 | 32.0 | 1984.0 | |
| 1449.0 | 1488.6 | 36.6 | 1979.4 | 9204 |
| .5 | 1493.1 | 41.1 | 1974.9 | |
| 1450.0 | 1497.7 | 45.7 | 1970.3 | 9244 |
| .5 | 1502.3 | 50.3 | 1965.7 | |
| 1451.0 | 1506.8 | 54.8 | 1961.2 | 9284 |
| .5 | 1511.4 | 59.4 | 1956.6 | |
| 1452.0 | 1516.0 | 64.0 | 1952.0 | 9324 |
| .5 | 1520.6 | 68.6 | 1947.4 | |
| 1453.0 | 1525.2 | 73.2 | 1942.8 | 9364 |
| .5 | 1529.8 | 77.8 | 1938.2 | |
| 1454.0 | 1534.4 | 82.4 | 1933.6 | 9404 |
| .5 | 1539.1 | 87.1 | 1928.9 | |
| 1455.0 | 1543.7 | 91.7 | 1924.3 | 9445 |
| .5 | 1548.3 | 96.3 | 1919.7 | |
| 1456.0 | 1552.9 | 100.9 | 1915.0 | 9485 |
| .5 | 1557.6 | 105.6 | 1910.4 | |
| 1457.0 | 1562.2 | 110.2 | 1905.8 | 9526 |
| .5 | 1566.9 | 114.9 | 1901.1 | |
| 1458.0 | 1571.5 | 119.5 | 1896.5 | 9567 |
| .5 | 1576.2 | 124.2 | 1891.8 | |
| 1459.0 | 1580.9 | 128.9 | 1887.1 | 9608 |
| .5 | 1585.6 | 133.6 | 1882.4 | |
| 1460.0 | 1590.2 | 138.2 | 1877.8 | 9649 |
| .5 | 1594.9 | 142.9 | 1873.1 | |
| 1461.0 | 1599.6 | 147.6 | 1868.4 | 9690 |
| .5 | 1604.3 | 152.3 | 1863.7 | |
| 1462.0 | 1609.0 | 157.0 | 1859.0 | 9732 |
| .5 | 1613.7 | 161.7 | 1854.3 | |
| 1463.0 | 1618.4 | 166.4 | 1849.6 | 9774 |
| .5 | 1623.1 | 171.1 | 1844.9 | |
| 1464.0 | 1627.9 | 175.9 | 1840.1 | 9815 |
| .5 | 1632.6 | 180.6 | 1835.4 | |
| 1465.0 | 1637.3 | 185.3 | 1830.7 | 9857 |
| .5 | 1642.1 | 190.1 | 1825.9 | |
| 1466.0 | 1646.8 | 194.8 | 1821.2 | 9899 |
| .5 | 1651.6 | 199.6 | 1816.4 | |
| 1467.0 | 1656.3 | 204.3 | 1811.7 | 9942 |
| .5 | 1661.1 | 209.1 | 1806.9 | |

TABLE 2-5

13340950 DWORSHAK RESERVOIR NEAR AHSAHKA, IDAHO
STORAGE CAPACITY IN 1,000 ACRE-FEET

| Elevation (feet) | Gross Storage | Usable Storage | Space Available | Area (acres) |
|---|---|---|---|---|
| 1468.0 | 1665.9 | 213.9 | 1802.1 | 9984 |
| .5 | 1670.6 | 218.6 | 1797.4 | |
| 1469.0 | 1675.4 | 223.4 | 1792.6 | 10026 |
| .5 | 1680.2 | 228.2 | 1787.8 | |
| 1470.0 | 1685.0 | 233.0 | 1783.0 | 10069 |
| .5 | 1639.8 | 237.8 | 1778.2 | |
| 1471.0 | 1694.6 | 242.6 | 1773.4 | 10112 |
| .5 | 1699.4 | 247.4 | 1768.6 | |
| 1472.0 | 1704.2 | 252.2 | 1763.8 | 10155 |
| .5 | 1709.0 | 257.0 | 1759.0 | |
| 1473.0 | 1713.9 | 261.9 | 1754.1 | 10198 |
| .5 | 1718.7 | 266.7 | 1749.3 | |
| 1474.0 | 1723.5 | 271.5 | 1744.5 | 10242 |
| .5 | 1728.4 | 276.4 | 1739.6 | |
| 1475.0 | 1733.2 | 281.2 | 1734.8 | 10285 |
| .5 | 1738.1 | 286.1 | 1729.9 | |
| 1476.0 | 1742.9 | 290.9 | 1725.1 | 10328 |
| .5 | 1747.8 | 295.8 | 1720.2 | |
| 1477.0 | 1752.7 | 300.7 | 1715.3 | 10372 |
| .5 | 1757.5 | 305.5 | 1710.5 | |
| 1478.0 | 1762.4 | 310.4 | 1705.6 | 10416 |
| .5 | 1767.3 | 315.3 | 1700.7 | |
| 1479.0 | 1772.2 | 320.2 | 1695.8 | 10460 |
| .5 | 1777.1 | 325.1 | 1690.9 | |
| 1480.0 | 1782.0 | 330.0 | 1686.0 | 10504 |
| .5 | 1786.9 | 334.9 | 1681.1 | |
| 1481.0 | 1791.9 | 339.9 | 1676.1 | 10549 |
| .5 | 1796.8 | 344.8 | 1671.2 | |
| 1482.0 | 1801.8 | 349.8 | 1666.2 | 10593 |
| .5 | 1806.8 | 354.8 | 1661.2 | |
| 1483.0 | 1811.8 | 359.8 | 1656.2 | 10638 |
| .5 | 1816.8 | 364.8 | 1651.2 | |
| 1484.0 | 1821.9 | 369.9 | 1646.1 | 10683 |
| .5 | 1826.9 | 374.9 | 1641.1 | |
| 1485.0 | 1832.0 | 380.0 | 1636.0 | 10728 |
| .5 | 1837.1 | 385.1 | 1630.9 | |
| 1486.0 | 1842.3 | 390.3 | 1625.7 | 10773 |
| .5 | 1847.4 | 395.4 | 1620.6 | |
| 1487.0 | 1852.6 | 400.6 | 1615.4 | 10819 |
| .5 | 1857.8 | 405.8 | 1610.2 | |
| 1488.0 | 1863.0 | 411.0 | 1605.0 | 10864 |
| .5 | 1868.2 | 416.2 | 1599.8 | |
| 1489.0 | 1873.4 | 421.4 | 1594.6 | 10910 |
| .5 | 1878.7 | 426.7 | 1589.3 | |
| 1490.0 | 1884.0 | 432.0 | 1584.0 | 10956 |
| .5 | 1889.3 | 437.3 | 1578.7 | |

13340950 DWORSHAK RESERVOIR NEAR AHSAHKA, IDAHO
STORAGE CAPACITY IN 1,000 ACRE-FEET

| Elevation (feet) | Gross Storage | Usable Storage | Space Available | Area (acres) |
|---|---|---|---|---|
| 1491.0 | 1894.6 | 442.6 | 1573.4 | 11001 |
| .5 | 1899.9 | 447.9 | 1568.1 | |
| 1492.0 | 1905.3 | 453.3 | 1562.7 | 11048 |
| .5 | 1910.7 | 458.7 | 1557.3 | |
| 1493.0 | 1916.1 | 464.1 | 1551.9 | 11094 |
| .5 | 1921.5 | 469.5 | 1546.5 | |
| 1494.0 | 1926.9 | 474.9 | 1541.1 | 11141 |
| .5 | 1932.4 | 480.4 | 1535.6 | |
| 1495.0 | 1937.9 | 485.9 | 1530.1 | 11187 |
| .5 | 1943.4 | 491.4 | 1524.6 | |
| 1496.0 | 1948.9 | 496.9 | 1519.1 | 11234 |
| .5 | 1954.4 | 502.4 | 1513.6 | |
| 1497.0 | 1960.0 | 508.0 | 1508.0 | 11281 |
| .5 | 1965.6 | 513.6 | 1502.4 | |
| 1498.0 | 1971.2 | 519.2 | 1496.8 | 11328 |
| .5 | 1976.8 | 524.8 | 1491.2 | |
| 1499.0 | 1982.4 | 530.4 | 1485.6 | 11375 |
| .5 | 1988.1 | 536.1 | 1479.9 | |
| 1500.0 | 1993.8 | 541.8 | 1474.2 | 11423 |
| .5 | 1999.5 | 547.5 | 1468.5 | |
| 1501.0 | 2005.2 | 553.2 | 1462.8 | 11470 |
| .5 | 2010.9 | 558.9 | 1457.1 | |
| 1502.0 | 2016.7 | 564.7 | 1451.3 | 11518 |
| .5 | 2022.5 | 570.5 | 1445.5 | |
| 1503.0 | 2028.3 | 576.3 | 1439.7 | 11566 |
| .5 | 2034.1 | 582.1 | 1433.9 | |
| 1504.0 | 2039.9 | 587.9 | 1428.1 | 11614 |
| .5 | 2045.8 | 593.8 | 1422.2 | |
| 1505.0 | 2051.7 | 599.7 | 1416.3 | 11663 |
| .5 | 2057.6 | 605.6 | 1410.4 | |
| 1506.0 | 2063.5 | 611.5 | 1404.5 | 11711 |
| .5 | 2069.5 | 617.5 | 1398.5 | |
| 1507.0 | 2075.4 | 623.4 | 1392.6 | 11760 |
| .5 | 2081.4 | 629.4 | 1386.6 | |
| 1508.0 | 2087.4 | 635.4 | 1380.6 | 11808 |
| .5 | 2093.5 | 641.5 | 1374.5 | |
| 1509.0 | 2099.5 | 647.5 | 1368.5 | 11857 |
| .5 | 2105.6 | 653.6 | 1362.4 | |
| 1510.0 | 2111.7 | 659.7 | 1356.3 | 11907 |
| .5 | 2117.8 | 665.8 | 1350.2 | |
| 1511.0 | 2123.9 | 671.9 | 1344.1 | 11956 |
| .5 | 2130.1 | 678.1 | 1337.9 | |
| 1512.0 | 2136.3 | 684.3 | 1331.7 | 12005 |
| .5 | 2142.5 | 690.5 | 1325.5 | |
| 1513.0 | 2148.7 | 696.7 | 1319.3 | 12055 |
| .5 | 2154.9 | 702.9 | 1313.1 | |

13340950 DWORSHAK RESERVOIR NEAR AHSAHKA, IDAHO
STORAGE CAPACITY IN 1,000 ACRE-FEET

| Elevation (feet) | Gross Storage | Usable Storage | Space Available | Area (acres) |
|---|---|---|---|---|
| 1514.0 | 2161.2 | 709.2 | 1306.8 | 12105 |
| .5 | 2167.5 | 715.5 | 1300.5 | |
| 1515.0 | 2173.8 | 721.8 | 1294.2 | 12155 |
| .5 | 2180.1 | 728.1 | 1287.9 | |
| 1516.0 | 2186.5 | 734.5 | 1281.5 | 12205 |
| .5 | 2192.8 | 740.8 | 1275.2 | |
| 1517.0 | 2199.2 | 747.2 | 1268.8 | 12255 |
| .5 | 2205.6 | 753.6 | 1262.4 | |
| 1518.0 | 2212.1 | 760.1 | 1255.9 | 12306 |
| .5 | 2218.5 | 766.5 | 1249.5 | |
| 1519.0 | 2225.0 | 773.0 | 1243.0 | 12356 |
| .5 | 2231.5 | 779.5 | 1236.5 | |
| 1520.0 | 2238.0 | 786.0 | 1230.0 | 12407 |
| .5 | 2244.6 | 792.6 | 1223.4 | |
| 1521.0 | 2251.1 | 799.1 | 1216.9 | 12459 |
| .5 | 2257.7 | 805.7 | 1210.3 | |
| 1522.0 | 2264.2 | 812.2 | 1203.8 | 12510 |
| .5 | 2270.8 | 818.8 | 1197.2 | |
| 1523.0 | 2277.4 | 825.4 | 1190.6 | 12561 |
| .5 | 2284.0 | 832.0 | 1184.0 | |
| 1524.0 | 2290.6 | 838.6 | 1177.4 | 12613 |
| .5 | 2297.2 | 845.2 | 1170.8 | |
| 1525.0 | 2303.9 | 851.9 | 1164.1 | 12664 |
| .5 | 2310.5 | 858.5 | 1157.5 | |
| 1526.0 | 2317.1 | 865.1 | 1150.9 | 12716 |
| .5 | 2323.8 | 871.8 | 1144.2 | |
| 1527.0 | 2330.5 | 878.5 | 1137.5 | 12769 |
| .5 | 2337.2 | 885.2 | 1130.8 | |
| 1528.0 | 2343.8 | 891.8 | 1124.2 | 12821 |
| .5 | 2350.5 | 898.5 | 1117.4 | |
| 1529.0 | 2357.3 | 905.3 | 1110.7 | 12873 |
| .5 | 2364.0 | 912.0 | 1104.0 | |
| 1530.0 | 2370.7 | 918.7 | 1097.3 | 12926 |
| .5 | 2377.5 | 925.5 | 1090.5 | |
| 1531.0 | 2384.2 | 932.2 | 1083.8 | 12979 |
| .5 | 2391.0 | 939.0 | 1077.0 | |
| 1532.0 | 2397.8 | 945.8 | 1070.2 | 13032 |
| .5 | 2404.5 | 952.5 | 1063.5 | |
| 1533.0 | 2411.3 | 959.3 | 1056.7 | 13085 |
| .5 | 2418.1 | 966.1 | 1049.9 | |
| 1534.0 | 2425.0 | 973.0 | 1043.0 | 13138 |
| .5 | 2431.8 | 979.8 | 1036.2 | |
| 1535.0 | 2438.6 | 986.6 | 1029.4 | 13192 |
| .5 | 2445.5 | 993.5 | 1022.5 | |
| 1536.0 | 2452.3 | 1000.3 | 1015.7 | 13246 |
| .5 | 2459.2 | 1007.2 | 1008.8 | |

13340950 DWORSHAK RESERVOIR NEAR AHSAHKA, IDAHO
STORAGE CAPACITY IN 1,000 ACRE-FEET

| Elevation (feet) | Gross Storage | Usable Storage | Space Available | Area (acres) |
|---|---|---|---|---|
| 1537.0 | 2466.1 | 014.1 | 1001.9 | 13300 |
| .5 | 2473.0 | 021.0 | 995.0 | |
| 1538.0 | 2479.9 | 027.9 | 988.1 | 13354 |
| .5 | 2486.8 | 034.8 | 981.2 | |
| 1539.0 | 2493.7 | 041.7 | 974.3 | 13408 |
| .5 | 2500.6 | 048.6 | 966.0 | |
| 1540.0 | 2507.6 | 055.6 | 960.4 | 13462 |
| .5 | 2514.5 | 062.5 | 953.5 | |
| 1541.0 | 2521.5 | 069.5 | 946.5 | 13517 |
| .5 | 2528.5 | 076.5 | 939.5 | |
| 1542.0 | 2535.4 | 083.4 | 932.6 | 13572 |
| .5 | 2542.4 | 090.4 | 925.6 | |
| 1543.0 | 2549.4 | 097.4 | 918.5 | 13627 |
| .5 | 2556.5 | 1104.5 | 911.5 | |
| 1544.0 | 2563.5 | 1111.5 | 904.5 | 13682 |
| .5 | 2570.5 | 1118.5 | 897.5 | |
| 1545.0 | 2577.6 | 1125.6 | 890.4 | 13738 |
| .5 | 2584.6 | 1132.6 | 883.4 | |
| 1546.0 | 2591.7 | 1139.7 | 876.3 | 13793 |
| .5 | 2598.8 | 1146.8 | 869.2 | |
| 1547.0 | 2605.9 | 1153.9 | 862.1 | 13849 |
| .5 | 2613.0 | 1161.0 | 855.0 | |
| 1548.0 | 2620.1 | 1168.1 | 847.9 | 13905 |
| .5 | 2627.2 | 1175.2 | 840.8 | |
| 1549.0 | 2634.4 | 1182.4 | 833.6 | 13961 |
| .5 | 2641.5 | 1189.5 | 826.5 | |
| 1550.0 | 2648.7 | 1196.7 | 819.3 | 14018 |
| .5 | 2655.8 | 1203.8 | 812.2 | |
| 1551.0 | 2663.0 | 1211.0 | 805.0 | 14074 |
| .5 | 2670.2 | 1218.2 | 797.8 | |
| 1552.0 | 2677.4 | 1225.4 | 790.6 | 14131 |
| .5 | 2684.6 | 1232.6 | 783.4 | |
| 1553.0 | 2691.8 | 1239.8 | 776.2 | 14188 |
| .5 | 2699.0 | 1247.0 | 769.0 | |
| 1554.0 | 2706.3 | 1254.3 | 761.7 | 14245 |
| .5 | 2713.5 | 1261.5 | 754.5 | |
| 1555.0 | 2720.8 | 1268.8 | 747.2 | 14302 |
| .5 | 2728.1 | 1276.1 | 739.9 | |
| 1556.0 | 2735.4 | 1283.4 | 732.6 | 14360 |
| .5 | 2742.6 | 1290.6 | 725.4 | |
| 1557.0 | 2750.0 | 1298.0 | 718.0 | 14418 |
| .5 | 2757.3 | 1305.3 | 710.7 | |
| 1558.0 | 2764.6 | 1312.6 | 703.4 | 14475 |
| .5 | 2771.9 | 1319.9 | 696.1 | |
| 1559.0 | 2779.3 | 1327.3 | 688.7 | 14534 |
| .5 | 2786.6 | 1334.6 | 681.4 | |

TABLE 2-5

13340950 DWORSHAK RESERVOIR NEAR AHSAHKA, IDAHO
STORAGE CAPACITY IN 1,000 ACRE-FEET

| Elevation (feet) | Gross Storage | Usable Storage | Space Available | Area (acres) |
|---|---|---|---|---|
| 1560.0 | 2794.0 | 1342.0 | 674.0 | 14592 |
| .5 | 2801.4 | 1349.4 | 666.6 | |
| 1561.0 | 2808.8 | 1356.8 | 659.2 | 14650 |
| .5 | 2816.3 | 1364.3 | 651.7 | |
| 1562.0 | 2823.7 | 1371.7 | 644.3 | 14709 |
| .5 | 2831.2 | 1379.2 | 636.8 | |
| 1563.0 | 2838.7 | 1386.7 | 629.3 | 14768 |
| .5 | 2846.3 | 1394.3 | 621.7 | |
| 1564.0 | 2953.8 | 1401.8 | 614.2 | 14827 |
| .5 | 2861.4 | 1409.4 | 606.6 | |
| 1565.0 | 2869.0 | 1417.0 | 599.0 | 14886 |
| .5 | 2876.7 | 1424.7 | 591.3 | |
| 1566.0 | 2884.4 | 1432.4 | 583.6 | 14946 |
| .5 | 2892.0 | 1440.0 | 576.0 | |
| 1567.0 | 2899.8 | 1447.8 | 568.2 | 15005 |
| .5 | 2907.5 | 1455.5 | 560.5 | |
| 1568.0 | 2915.3 | 1463.3 | 552.7 | 15065 |
| .5 | 2923.1 | 1471.1 | 544.9 | |
| 1569.0 | 2930.9 | 1478.9 | 537.1 | 15125 |
| .5 | 2938.7 | 1486.7 | 529.3 | |
| 1570.0 | 2946.6 | 1494.6 | 521.4 | 15186 |
| .5 | 2954.5 | 1502.5 | 513.5 | |
| 1571.0 | 2962.4 | 1510.4 | 505.6 | 15246 |
| .5 | 2970.4 | 1518.4 | 497.6 | |
| 1572.0 | 2978.4 | 1526.4 | 489.6 | 15307 |
| .5 | 2986.4 | 1534.4 | 481.6 | |
| 1573.0 | 2994.4 | 1542.4 | 473.6 | 15368 |
| .5 | 3002.5 | 1550.5 | 465.5 | |
| 1574.0 | 3010.5 | 1558.5 | 457.5 | 15429 |
| .5 | 3018.6 | 1566.6 | 449.4 | |
| 1575.0 | 3026.8 | 1574.8 | 441.2 | 15490 |
| .5 | 3034.9 | 1582.9 | 433.1 | |
| 1576.0 | 3043.1 | 1591.1 | 424.9 | 15552 |
| .5 | 3051.3 | 1599.3 | 416.7 | |
| 1577.0 | 3059.6 | 1607.6 | 408.4 | 15613 |
| .5 | 3067.8 | 1615.8 | 400.2 | |
| 1578.0 | 3076.3 | 1624.1 | 391.9 | 15675 |
| .5 | 3084.5 | 1632.5 | 383.5 | |
| 1579.0 | 3092.8 | 1640.8 | 375.2 | 15737 |
| .5 | 3101.2 | 1649.2 | 366.8 | |
| 1580.0 | 3109.6 | 1657.6 | 358.4 | 15800 |
| .5 | 3118.0 | 1666.0 | 350.0 | |
| 1581.0 | 3126.4 | 1674.4 | 341.6 | 15862 |
| .5 | 3134.9 | 1682.9 | 333.1 | |
| 1582.0 | 3143.4 | 1691.4 | 324.6 | 15925 |
| .5 | 3152.0 | 1700.0 | 316.0 | |

13340950 DWORSHAK RESERVOIR NEAR AHSAHKA, IDAHO
STORAGE CAPACITY IN 1,000 ACRE-FEET

| Elevation (feet) | Gross Storage | Usable Storage | Space Available | Area (acres) |
|---|---|---|---|---|
| 1583.0 | 3160.5 | 1708.5 | 307.5 | 15988 |
| .5 | 3165.7 | 1713.7 | 302.7 | |
| 1584.0 | 3177.7 | 1725.7 | 290.3 | 16051 |
| .5 | 3186.4 | 1734.4 | 281.6 | |
| 1585.0 | 3195.0 | 1743.0 | 273.0 | 16114 |
| .5 | 3203.7 | 1751.7 | 264.3 | |
| 1586.0 | 3212.5 | 1760.5 | 255.5 | 16178 |
| .5 | 3221.2 | 1769.2 | 246.8 | |
| 1587.0 | 3230.0 | 1778.0 | 238.0 | 16242 |
| .5 | 3238.8 | 1786.8 | 229.2 | |
| 1588.0 | 3247.6 | 1795.6 | 220.4 | 16306 |
| .5 | 3256.5 | 1804.5 | 211.5 | |
| 1589.0 | 3265.4 | 1813.4 | 202.6 | 16370 |
| .5 | 3274.3 | 1822.3 | 193.7 | |
| 1590.0 | 3283.2 | 1831.2 | 184.8 | 16435 |
| .5 | 3292.2 | 1840.2 | 175.8 | |
| 1591.0 | 3301.2 | 1849.2 | 166.8 | 16499 |
| .5 | 3310.2 | 1858.2 | 157.8 | |
| 1592.0 | 3319.3 | 1867.3 | 148.7 | 16564 |
| .5 | 3328.4 | 1876.4 | 139.6 | |
| 1593.0 | 3337.5 | 1885.5 | 130.5 | 16629 |
| .5 | 3346.6 | 1894.6 | 121.6 | |
| 1594.0 | 3355.8 | 1903.8 | 112.8 | 16694 |
| .5 | 3365.0 | 1913.0 | 103.0 | |
| 1595.0 | 3374.2 | 1922.2 | 93.8 | 16760 |
| .5 | 3383.4 | 1931.4 | 84.6 | |
| 1596.0 | 3392.7 | 1940.7 | 75.3 | 16826 |
| .5 | 3402.0 | 1950.0 | 66.0 | |
| 1597.0 | 3411.3 | 1959.3 | 56.7 | 16891 |
| .5 | 3420.7 | 1968.7 | 47.3 | |
| 1598.0 | 3430.1 | 1978.1 | 37.9 | 16957 |
| .5 | 3439.5 | 1987.5 | 28.5 | |
| 1599.0 | 3448.9 | 1996.9 | 19.1 | 17024 |
| .5 | 3458.4 | 2006.4 | 9.6 | |
| 1600.0 | 3468.0 | 2016.0 | 0.0 | 17090 |

# TABLE 2-6

## DWORSHAK PUBLIC RECREATION FACILITIES

| Recreation Areas | Elevation (ft. msl) | Acres Developed | Acres Total | Major Use | Operational Elev. (ft msl) Boat Ramp | Boat Dock | Swimming Area |
|---|---|---|---|---|---|---|---|
| Big Eddy | 1615 | 4 | 20 | Boat launching, swimming, picnicking, hiking, marina | 1445+ | 1560+ | 1595+ |
| Boehls | 1600-1650 | 1 | 42 | Primitive camping, picnicking | -- | -- | -- |
| Bruces Eddy | 1620 | 7 | 66 | Boat launching | 1485+ | 1590+ | -- |
| Canyon Creek | 1600-1650 | 10 | 75 | Boat launching, camping | 1587+ | -- | -- |
| Cold Springs | 1600-1650 | 2 | 31 | Primitive group camping | -- | -- | -- |
| Dent Acres | 1600-1750 | 85 | 366 | Boat launching, camping, picnicking, swimming, hiking | 1525+ | 1560+ | -- |
| Dent Orchards | 1600-1650 | 50 | 149 | Picnicking, hiking | -- | -- | -- |
| Freeman Creek | 1600-1750 | 80 | 272 | Boat launching, swimming, picnicking, hiking, playground | 1535+ | 1560+ | 1595+ |
| Grandad Creek | 1610 | 5 | 66 | Boat launching, primitive camping, picnicking | 1555+ | -- | -- |
| Little North Fk. | 1625 | 3 | 14 | Primitive camping | -- | -- | -- |
| Magnus Bay | 1600-1700 | 6 | 150 | Primitive camping | -- | -- | -- |
| Merrys Bay | 1600-1650 | 8 | 46 | Picnicking, swimming, hiking, playground | -- | -- | 1595+ |
| Mini-camps | 1600-1650 | 50 | 100 | Camping and picnicking, 78 areas (varies annually) | -- | -- | -- |
| Picnic Glen | 1620-1640 | 3 | 6 | Picnicking, hiking | -- | -- | -- |
| Three Meadows | 1740-1780 | 10 | 78 | Developed group camp | -- | -- | -- |
| Viewpoint #2 | 1620 | 2 | 3 | Sightseeing | -- | -- | -- |
| Visitor Center | 1620 | 2 | 2 | Sightseeing | -- | 1590+ | -- |

Sources: Walla Walla District Recreational Facilities Guide, March 1984.
Dworshak Master Plan, Vol. 1, July 1985.

# TABLE 4-1

EXTREMES FOR AVERAGE MAXIMUM MONTHLY TEMPERATURES

| Month | Avery R.S.2 1/ | | Elk River 1S 2/ | | Headquarters 3/ | | Mullan 4/ | | North Star Ranch 5/ | | Orofino 6/ | | Pierce 7/ | | Powell 8/ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min |
| Jan | 36.8 | 19.7 | 41.3 | 25.6 | 41.4 | 26.0 | 41.4 | 24.4 | 41.6 | 23.7 | 48.2 | 24.5 | 35.7 | 26.4 | 39.4 | 23.6 |
| Feb | 39.8 | 31.1 | 46.9 | 34.9 | 47.0 | 36.3 | 45.1 | 35.5 | 48.1 | 38.2 | 56.3 | 30.7 | 40.5 | 33.3 | 43.0 | 33.2 |
| Mar | 52.5 | 40.8 | 51.3 | 38.3 | 52.8 | 39.4 | 51.1 | 40.3 | 57.7 | 45.6 | 67.3 | 45.6 | 51.4 | 37.8 | 52.3 | 36.8 |
| Apr | 64.1 | 45.8 | 63.4 | 47.2 | 61.2 | 45.8 | 60.8 | 52.3 | 66.6 | 51.7 | 77.8 | 58.4 | 54.1 | 45.0 | 60.0 | 45.1 |
| May | 72.0 | 59.0 | 77.8 | 58.4 | 72.3 | 55.6 | 65.9 | 56.6 | 72.9 | 61.0 | 88.4 | 65.2 | 70.3 | 56.9 | 70.2 | 55.6 |
| Jun | 81.2 | 65.8 | 80.6 | 66.0 | 81.7 | 65.2 | 75.4 | 63.1 | 82.7 | 70.7 | 91.7 | 74.5 | 76.5 | 65.0 | 79.5 | 65.4 |
| Jul | 89.6 | 77.8 | 87.6 | 77.5 | 88.8 | 76.7 | 80.9 | 75.2 | 88.8 | 81.5 | 100.5 | 83.8 | 85.6 | 77.5 | 88.0 | 78.6 |
| Aug | 87.6 | 75.7 | 90.9 | 75.3 | 90.5 | 73.7 | 83.7 | 70.2 | 94.6 | 77.4 | 99.7 | 81.0 | 87.0 | 73.2 | 90.3 | 74.1 |
| Sep | 75.2 | 63.8 | 81.0 | 63.3 | 81.1 | 63.3 | 73.4 | 62.3 | 85.7 | 66.9 | 89.7 | 71.9 | 77.5 | 60.2 | 82.4 | 60.6 |
| Oct | 62.3 | 51.6 | 72.4 | 53.4 | 64.0 | 52.4 | 60.1 | 55.9 | 66.4 | 51.5 | 76.6 | 53.6 | 63.8 | 49.6 | 65.3 | 51.7 |
| Nov | 41.4 | 34.4 | 49.6 | 35.4 | 47.9 | 36.8 | 44.2 | 36.1 | 47.2 | 39.0 | 55.3 | 40.0 | 45.1 | 35.6 | 44.7 | 34.0 |
| Dec | 35.5 | 36.8 | 40.3 | 29.7 | 38.8 | 30.7 | 39.6 | 27.3 | 38.6 | 29.5 | 47.0 | 32.0 | 34.0 | 28.1 | 36.1 | 26.3 |

1/ Period of Record, 1968 - 1981, 14 years, station elevation 2,390 feet msl.
2/ Period of Record, 1952 - 1981, 30 years, station elevation 2,918 feet msl.
3/ Period of Record, 1959 - 1981, 23 years, station elevation 3,138 feet msl.
4/ Period of Record, 1975 - 1981, 7 years, station elevation 3,317 feet msl.
5/ Period of Record, 1967 - 1981, 15 years, station elevation 2,800 feet msl.
6/ Period of Record, 1903 - 1981, 79 years, station elevation 1,027 feet msl.
7/ Period of Record, 1963 - 1981, 19 years, station elevation 3,185 feet msl.
8/ Period of Record, 1962 - 1981, 20 years, station elevation 3,632 feet msl.

Source of Data: Corps of Engineers, Walla Walla District, Hydrology Branch

# TABLE 4-2

EXTREMES FOR AVERAGE MINIMUM MONTHLY TEMPERATURES

| Month | Avery R.S.2 1/ | | Elk River 1S 2/ | | Headquarters 3/ | | Mullan 4/ | | North Star Ranch 5/ | | Orofino 6/ | | Pierce 7/ | | Powell 8/ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min |
| Jan | 28.4 | 5.9 | 30.0 | 1.9 | 26.4 | 2.3 | 28.2 | 7.3 | 26.7 | 2.8 | 35.1 | 3.8 | 24.7 | -0.5 | 24.0 | 1.2 |
| Feb | 30.9 | 19.9 | 29.3 | 12.7 | 27.8 | 13.3 | 26.3 | 21.8 | 25.9 | 15.9 | 34.4 | 5.7 | 22.9 | 11.9 | 23.4 | 13.2 |
| Mar | 34.4 | 22.7 | 28.4 | 14.0 | 28.5 | 15.8 | 28.6 | 21.5 | 28.6 | 19.3 | 35.9 | 25.1 | 27.1 | 13.7 | 26.2 | 12.7 |
| Apr | 36.7 | 28.8 | 36.4 | 26.7 | 32.9 | 24.7 | 34.0 | 30.4 | 34.1 | 27.5 | 41.3 | 31.4 | 32.6 | 26.1 | 31.2 | 24.6 |
| May | 43.5 | 36.2 | 49.0 | 32.7 | 38.2 | 31.0 | 39.8 | 35.1 | 39.0 | 33.2 | 48.9 | 37.3 | 38.5 | 31.4 | 36.6 | 31.3 |
| Jun | 49.2 | 42.3 | 47.8 | 37.8 | 46.8 | 37.4 | 45.7 | 40.9 | 47.1 | 41.2 | 54.9 | 44.2 | 43.4 | 38.1 | 43.8 | 38.3 |
| Jul | 51.5 | 45.7 | 53.7 | 39.9 | 51.1 | 39.7 | 47.9 | 45.4 | 52.7 | 43.5 | 59.4 | 48.4 | 49.3 | 40.3 | 49.8 | 41.6 |
| Aug | 50.6 | 45.2 | 46.7 | 39.3 | 46.5 | 39.4 | 49.3 | 43.0 | 47.5 | 40.2 | 55.8 | 42.7 | 45.5 | 37.3 | 46.5 | 38.4 |
| Sep | 46.1 | 38.6 | 42.3 | 32.0 | 41.2 | 28.9 | 42.1 | 39.8 | 42.3 | 32.6 | 52.7 | 39.1 | 38.2 | 30.5 | 41.1 | 31.6 |
| Oct | 36.7 | 28.9 | 35.4 | 26.0 | 32.3 | 23.8 | 35.0 | 30.6 | 34.0 | 27.1 | 43.7 | 30.3 | 31.0 | 26.0 | 33.9 | 26.0 |
| Nov | 31.9 | 20.9 | 30.5 | 18.6 | 28.6 | 17.3 | 29.3 | 21.8 | 27.1 | 19.1 | 37.6 | 22.2 | 26.4 | 19.3 | 28.2 | 17.4 |
| Dec | 29.0 | 13.1 | 30.0 | 9.2 | 26.2 | 13.9 | 28.3 | 13.2 | 24.7 | 11.0 | 35.0 | 9.9 | 22.6 | 9.6 | 23.5 | 8.6 |

1/ Period of Record, 1968 - 1981, 14 years, station elevation 2,390 feet msl.
2/ Period of Record, 1952 - 1981, 30 years, station elevation 2,918 feet msl.
3/ Period of Record, 1959 - 1981, 23 years, station elevation 3,138 feet msl.
4/ Period of Record, 1975 - 1981, 7 years, station elevation 3,317 feet msl.
5/ Period of Record, 1967 - 1981, 15 years, station elevation 2,800 feet msl.
6/ Period of Record, 1903 - 1981, 79 years, station elevation 1,027 feet msl.
7/ Period of Record, 1963 - 1981, 19 years, station elevation 3,185 feet msl.
8/ Period of Record, 1962 - 1981, 20 years, station elevation 3,632 feet msl.

Source of Data: Corps of Engineers, Walla Walla District, Hydrology Branch

# TABLE 4-3

MONTHLY EXTREME MAXIMUM AND MINIMUM TEMPERATURES

| Month | Avery R.S.2 1/ | | Elk River 1S 2/ | | Headquarters 3/ | | Mullan 4/ | | North Star Ranch 5/ | | Orofino 6/ | | Pierce 7/ | | Powell 8/ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min |
| Jan | 47 | -17 | 54 | -31 | 55 | -27 | 53 | -20 | 58 | -21 | 62 | -22 | 51 | -29 | 47 | -28 |
| Feb | 52 | -9 | 63 | -25 | 64 | -18 | 65 | -8 | 62 | -14 | 68 | -23 | 58 | -17 | 61 | -16 |
| Mar | 75 | 0 | 70 | -23 | 72 | -10 | 74 | -3 | 80 | 4 | 82 | -1 | 75 | -6 | 73 | -12 |
| Apr | 88 | 21 | 83 | 11 | 87 | 4 | 87 | 19 | 92 | 16 | 98 | 20 | 88 | 14 | 86 | 10 |
| May | 89 | 25 | 91 | 19 | 93 | 19 | 81 | 26 | 94 | 20 | 105 | 26 | 92 | 21 | 91 | 20 |
| Jun | 96 | 31 | 96 | 29 | 97 | 25 | 93 | 30 | 101 | 30 | 110 | 31 | 96 | 28 | 99 | 26 |
| Jul | 101 | 34 | 104 | 29 | 102 | 26 | 94 | 34 | 105 | 30 | 118 | 37 | 101 | 29 | 102 | 28 |
| Aug | 104 | 3 | 107 | 27 | 108 | 28 | 94 | 31 | 105 | 32 | 116 | 33 | 97 | 28 | 105 | 24 |
| Sep | 97 | 4 | 100 | 21 | 99 | 21 | 92 | 28 | 101 | 23 | 107 | 21 | 97 | 18 | 98 | 21 |
| Oct | 78 | 11 | 88 | 4 | 85 | 4 | 83 | 20 | 85 | 4 | 92 | 14 | 86 | 3 | 86 | 2 |
| Nov | 59 | 4 | 66 | -13 | 68 | -5 | 65 | 0 | 67 | -3 | 71 | -6 | 69 | -2 | 66 | -10 |
| Dec | 50 | -23 | 58 | -37 | 55 | -28 | 52 | -21 | 54 | -18 | 63 | -24 | 45 | -33 | 45 | -28 |

1/ Period of Record, 1968 - 1981, 14 years, station elevation 2,390 feet msl.
2/ Period of Record, 1952 - 1981, 30 years, station elevation 2,918 feet msl.
3/ Period of Record, 1959 - 1981, 23 years, station elevation 3,138 feet msl.
4/ Period of Record, 1975 - 1981, 7 years, station elevation 3,317 feet msl.
5/ Period of Record, 1967 - 1981, 15 years, station elevation 2,800 feet msl.
6/ Period of Record, 1903 - 1981, 79 years, station elevation 1,027 feet msl.
7/ Period of Record, 1963 - 1981, 19 years, station elevation 3,185 feet msl.
8/ Period of Record, 1962 - 1981, 20 years, station elevation 3,632 feet msl.

Source of Data: Corps of Engineers, Walla Walla District, Hydrology Branch.

## TABLE 4-4

TOTAL MONTHLY PRECIPITATION

| Month | Avery R.S.2 1/ | | | Elk River 1S 2/ | | | Headquarters 3/ | | | Mullan 4/ | | | North Star Ranch 5/ | | | Orofino 6/ | | | Pierce 7/ | | | Powell 8/ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Max | Min | Avg | Max | Min | Avg | Max | Min | Avg | Max | Min | Avg | Max | Min | Avg | Max | Min | Avg | Max | Min | Avg | Max | Min | Avg |
| Jan | 10.15 | 1.58 | 6.22 | 12.33 | 2.13 | 5.99 | 10.08 | 1.80 | 5.83 | 15.80 | 1.02 | 4.98 | 16.31 | 0.73 | 3.45 | 8.16 | 0.58 | 2.98 | 10.59 | 1.80 | 6.04 | 11.52 | 0.90 | 6.64 |
| Feb | 8.00 | 0.77 | 3.65 | 7.82 | 0.79 | 4.21 | 8.47 | 1.73 | 3.96 | 7.50 | 1.20 | 4.05 | 5.28 | 0.73 | 2.26 | 6.04 | 0.05 | 2.56 | 8.59 | 1.29 | 4.16 | 9.95 | 1.01 | 3.98 |
| Mar | 5.27 | 0.85 | 3.27 | 7.14 | 1.06 | 3.81 | 6.37 | 1.36 | 3.83 | 5.20 | 1.88 | 3.23 | 4.29 | 0.53 | 1.99 | 5.83 | 0.47 | 2.61 | 6.13 | 1.55 | 3.82 | 7.03 | 0.65 | 3.32 |
| Apr | 4.60 | 0.41 | 2.82 | 6.74 | 0.18 | 3.03 | 5.37 | 0.22 | 3.30 | 4.21 | 0.49 | 2.38 | 3.13 | 0.44 | 2.15 | 4.64 | 0.31 | 2.16 | 5.36 | 0.74 | 3.57 | 4.47 | 0.39 | 2.48 |
| May | 5.08 | 1.92 | 2.87 | 5.17 | 0.86 | 2.74 | 5.47 | 0.58 | 3.04 | 4.97 | 1.40 | 2.93 | 3.50 | 1.15 | 2.20 | 6.97 | 0.00 | 2.26 | 5.75 | 1.51 | 3.31 | 5.09 | 1.38 | 2.64 |
| Jun | 5.36 | 0.38 | 2.46 | 4.75 | 0.79 | 2.36 | 6.35 | 0.49 | 2.55 | 5.29 | 0.37 | 2.27 | 5.03 | 0.77 | 2.32 | 5.43 | 0.07 | 2.03 | 7.29 | 1.02 | 3.16 | 7.48 | 0.73 | 3.25 |
| Jul | 3.00 | 0.00 | 1.24 | 2.36 | 0.00 | 0.82 | 2.37 | 0.00 | 0.96 | 2.30 | 0.00 | 1.25 | 2.40 | 0.10 | 1.13 | 4.32 | 0.00 | 0.69 | 3.65 | 0.00 | 1.08 | 2.80 | 0.05 | 1.21 |
| Aug | 4.26 | 0.03 | 1.69 | 3.67 | 0.00 | 1.26 | 4.18 | 0.00 | 1.51 | 3.48 | 0.30 | 1.86 | 4.26 | 0.05 | 1.37 | 2.75 | 0.00 | 0.70 | 4.74 | 0.00 | 1.74 | 4.35 | 0.05 | 1.80 |
| Sep | 4.14 | 0.21 | 2.12 | 7.79 | 0.00 | 1.86 | 7.76 | 0.14 | 2.20 | 3.49 | 0.20 | 1.74 | 3.93 | 0.08 | 1.84 | 5.04 | 0.00 | 1.46 | 4.52 | 0.46 | 2.34 | 5.10 | 0.13 | 2.27 |
| Oct | 6.05 | 0.06 | 2.17 | 5.69 | 0.01 | 2.75 | 6.33 | 0.00 | 3.12 | 5.20 | 0.10 | 1.99 | 5.03 | 0.12 | 1.93 | 5.92 | 0.06 | 2.14 | 6.96 | 0.25 | 3.20 | 7.91 | 0.50 | 3.03 |
| Nov | 6.89 | 1.36 | 3.74 | 10.70 | 1.10 | 4.42 | 10.55 | 1.08 | 4.69 | 10.40 | 1.01 | 4.64 | 4.58 | 1.06 | 2.56 | 9.66 | 0.18 | 3.21 | 8.58 | 1.09 | 4.29 | 8.41 | 0.79 | 4.26 |
| Dec | 10.43 | 2.79 | 5.61 | 13.13 | 1.93 | 5.51 | 12.57 | 1.51 | 5.39 | 9.99 | 2.18 | 5.75 | 6.87 | 1.21 | 3.35 | 12.01 | 0.22 | 3.34 | 11.10 | 1.92 | 6.02 | 12.65 | 1.77 | 5.95 |

1/ Period of Record, 1968 - 1981, 14 years, station elevation 2,390 feet msl.
2/ Period of Record, 1952 - 1981, 30 years, station elevation 2,918 feet msl.
3/ Period of Record, 1959 - 1981, 23 years, station elevation 3,138 feet msl.
4/ Period of Record, 1975 - 1981, 7 years, station elevation 3,317 feet msl.
5/ Period of Record, 1967 - 1981, 15 years, station elevation 2,800 feet msl.
6/ Period of Record, 1903 - 1981, 79 years, station elevation 1,027 feet msl.
7/ Period of Record, 1963 - 1981, 19 years, station elevation 3,185 feet msl.
8/ Period of Record, 1962 - 1981, 20 years, station elevation 3,632 feet msl.

Source of Data: Corps of Engineers, Walla Walla District, Hydrology Branch.

# TABLE 4-7

TOTAL EVAPORATION IN INCHES

STATION - MOSCOW-UNIVERSITY OF IDAHO
STATION NO. - 10-6152, ELEVATION - 2660 FMSL

| Year | Apr | May | Jun | Jul | Aug | Sep | Oct |
|---|---|---|---|---|---|---|---|
| 1939 | -- | -- | 5.32E | 7.93 | 7.72 | 5.18E | -- |
| 1940 | 3.69E | 5.15 | 5.57 | 7.14E | 6.93 | 3.74E | 2.24E |
| 1941 | -- | 3.98E | 4.53E | 7.48 | 5.35 | 2.66E | -- |
| 1942 | -- | 3.55E | 4.76 | 7.75 | 7.34E | 3.67E | -- |
| 1943 | -- | 4.19 | 4.21 | 6.95 | -- | 3.58E | -- |
| 1944 | -- | -- | -- | 8.33 | 6.04 | 3.80 | -- |
| 1945 | -- | 4.40 | 5.04 | 8.20 | 5.36 | 2.66 | -- |
| 1946 | 2.62 | 3.39 | 5.37 | 7.34 | 5.66 | 2.93 | -- |
| 1947 | -- | 5.71 | 5.11 | 8.43 | 6.33 | 3.90 | -- |
| 1948 | 1.90 | 3.28 | 5.16 | 5.69 | 4.35 | 3.08 | -- |
| 1949 | 3.12 | 4.38 | 6.75 | 8.42 | 8.62 | 5.16 | -- |
| 1950 | 3.53 | 6.12 | 5.50E | 8.10 | 7.39 | 5.07 | -- |
| 1951 | 4.92 | 5.39 | 6.35 | 9.10 | 7.87 | 5.03 | -- |
| 1952 | 4.26 | 4.93 | 5.48 | 8.54 | 8.29 | 5.09 | -- |
| 1953 | -- | 4.50E | 5.13E | 8.59E | 6.59 | 5.75E | -- |
| 1954 | 3.67 | 5.18 | 4.85 | 7.75 | 5.52 | 3.97 | -- |
| 1955 | 2.42 | 4.74 | 6.56 | 6.25 | 8.01 | 4.58 | -- |
| 1956 | 4.29 | 3.57 | 5.09 | 8.30 | 6.37 | 4.76 | 1.90 |
| 1957 | 3.33 | 4.37 | 5.82 | 8.19 | 7.45 | 5.40 | -- |
| 1958 | 2.37 | 6.17 | 5.95 | 9.53 | 9.70 | 5.36 | -- |
| 1959 | 3.89 | 4.49 | 6.30 | 9.29E | 8.14 | 3.34 | -- |
| 1960 | 2.96 | 4.64 | 7.36 | 8.73E | 5.78E | -- | -- |
| 1961 | 3.16 | 5.98 | 6.45 | 9.05 | 9.02 | 5.59 | -- |
| 1962 | 5.01 | 3.68 | 6.32 | 8.97 | 7.11 | 6.02 | -- |
| 1963 | 3.36E | 6.07 | 5.65 | 8.11 | 8.57 | 6.21 | -- |
| 1964 | 3.33 | 5.57 | 5.45 | 7.40 | 6.34 | 3.95 | -- |
| 1965 | 3.40 | 6.13 | 7.27 | 8.60E | 7.10 | 4.09 | -- |
| 1966 | 4.59 | 7.81 | 5.68 | 8.58 | 8.38 | 6.26 | 2.47 |
| 1967 | 2.81 | 5.24 | 6.54E | 8.95E | 9.84 | 6.42 | 2.96 |
| 1968 | 4.45 | 6.65 | 7.20 | 9.86 | 6.56 | 4.78 | -- |
| 1969 | 4.52 | 5.44 | 7.35 | 9.29 | 9.75 | 5.29 | -- |
| 1970 | -- | -- | 7.03 | 8.86 | 9.77 | 4.72 | 3.58E |
| 1971 | -- | 6.17 | 5.61 | 9.37 | 9.39 | 4.53E | 2.79 |
| 1972 | -- | -- | 6.13E | 8.91 | 9.59E | 5.85 | -- |
| 1973 | 4.54E | 6.90 | 7.54 | 11.44E | 9.70 | 5.46 | 2.72 |
| 1974 | -- | -- | -- | 7.32 | 8.17 | 6.56 | 3.70 |
| 1975 | -- | -- | 6.57E | 8.11 | 7.92 | 5.89 | 2.89E |
| 1976 | -- | 7.25E | 6.20 | 7.86 | 6.39 | 6.14 | 3.66 |
| 1977 | -- | 4.86 | 8.73 | 9.84 | 10.78 | 4.64 | -- |
| 1978 | -- | 5.04 | 8.19 | 8.32 | 7.08 | 4.27 | 3.57 |
| 1979 | 3.83 | -- | 7.96 | 9.77 | 8.58 | 6.48 | -- |
| 1980 | -- | -- | 5.78 | 8.37 | 8.55 | -- | 3.94 |
| N | 25 | 34 | 40 | 42 | 41 | 40 | 12 |
| Mean | 3.60 | 5.14 | 6.15 | 8.41 | 7.64 | 4.78 | 3.04 |
| Max | 5.01 | 7.81 | 8.73 | 11.44 | 10.78 | 6.42 | 3.94 |
| Min | 1.90 | 3.28 | 4.21 | 5.69 | 5.35 | 2.66 | 1.90 |

E Estimated Values During Month
Dashes (--) denote missing numbers.

## TABLE 4-13

NORTH FORK CLEARWATER RIVER NEAR CANYON RANGER STATION (13340600)
Monthly Discharge Volume in 1,000 acre-feet
Drainage Area: 1,360 square miles

| Water Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1968 | 90.0 | 106.7 | 100.0 | 94.2 | 250.4 | 265.6 | 250.0 | 558.9 | 459.2 | 128.1 | 72.9 | 99.7 |
| 1969 | 144.2 | 177.6 | 128.4 | 206.5 | 99.3 | 150.2 | 523.0 | 815.7 | 370.2 | 130.1 | 59.5 | 49.7 |
| 1970 | 60.3 | 48.5 | 67.6 | 134.0 | 130.3 | 137.5 | 189.1 | 692.3 | 644.7 | 157.6 | 67.8 | 63.6 |
| 1971 | 62.1 | 110.9 | 102.9 | 166.4 | 268.4 | 164.9 | 379.3 | 1080.8 | 742.9 | 247.2 | 79.9 | 61.7 |
| 1972 | 59.4 | 56.3 | 52.7 | 100.5 | 130.1 | 434.0 | 381.8 | 1207.1 | 973.5 | 253.9 | 74.7 | 57.2 |
| 1973 | 55.0 | 52.6 | 104.7 | 114.4 | 64.7 | 105.6 | 179.0 | 366.2 | 219.9 | 82.2 | 42.9 | 41.9 |
| 1974 | 44.6 | 133.9 | 134.8 | 314.0 | 139.6 | 213.1 | 464.4 | 803.0 | 1227.4 | 289.2 | 94.3 | 56.6 |
| 1975 | 48.1 | 56.4 | 48.6 | 78.5 | 52.8 | 97.6 | 161.3 | 651.3 | 853.0 | 303.4 | 105.3 | 67.0 |
| 1976 | 91.6 | 136.9 | 321.6 | 171.9 | 111.4 | 123.8 | 390.8 | 965.1 | 521.0 | 194.0 | 100.8 | 65.6 |
| 1977 | 54.7 | 54.4 | 47.2 | 53.9 | 53.7 | 76.7 | 253.8 | 369.6 | 182.6 | 70.8 | 51.0 | 56.5 |
| 1978 | 66.1 | 105.0 | 323.5 | 124.1 | 105.2 | 247.5 | 404.0 | 559.3 | 460.5 | 177.3 | 86.3 | 61.8 |
| 1979 | 45.9 | 48.2 | 43.5 | 40.9 | 62.5 | 177.3 | 296.8 | 836.5 | 423.8 | 126.0 | 62.3 | 45.4 |
| 1980 | 52.6 | 40.2 | 88.3 | 71.0 | 93.6 | 122.7 | 396.0 | 575.6 | 356.2 | 138.2 | 68.9 | 67.7 |
| 1981 | 50.3 | 83.4 | 230.6 | 189.9 | 181.5 | 173.6 | 309.4 | 479.6 | 473.0 | 175.2 | 74.9 | 56.1 |
| 1982 | 56.9 | 68.4 | 100.9 | 71.4 | 240.8 | 265.2 | 338.9 | 825.6 | 751.1 | 277.2 | 91.1 | 59.5 |
| 1983 | 71.3 | 72.1 | 79.9 | 124.4 | 131.9 | 276.8 | 264.5 | 517.9 | 382.4 | 178.7 | 86.6 | 59.1 |
| 1984 | 55.5 | 119.3 | 58.7 | 139.9 | 112.3 | 193.5 | 373.2 | 656.5 | 676.6 | 193.9 | 73.2 | 56.1 |
| 1985 | 58.2 | 95.6 | 62.5 | 50.5 | 40.1 | 89.2 | 456.8 | 822.0 | 519.0 | 112.1 | 72.9 | 92.9 |
| STATISTICS | | | | | | | | | | | | |
| N | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 |
| AVERAGE | 64.8 | 87.0 | 116.5 | 124.8 | 126.0 | 184.1 | 334.0 | 710.2 | 568.7 | 179.7 | 75.9 | 62.1 |
| MAXIMUM | 144.2 | 177.6 | 323.5 | 314.0 | 268.4 | 434.0 | 523.0 | 1207.1 | 1227.4 | 303.4 | 105.3 | 99.7 |
| MINIMUM | 44.6 | 40.2 | 43.5 | 40.9 | 40.1 | 76.7 | 161.3 | 366.2 | 182.6 | 70.8 | 42.9 | 41.9 |

# TABLE 4-14

DWORSHAK RESERVOIR (13340950)
Unregulated Monthly Inflow Volume in 1,000 acre-feet
Drainage Area: 2,440 Square Miles

| Water Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1927 | 145.1 | 277.5 | 323.0 | 254.2 | 251.4 | 303.5 | 649.6 | 1259.9 | 1213.3 | 312.7 | 117.2 | 135.4 |
| 1928 | 249.6 | 1003.4 | 586.0 | 487.9 | 264.3 | 599.2 | 699.0 | 1853.6 | 584.0 | 192.8 | 92.6 | 66.6 |
| 1929 | 95.7 | 81.8 | 67.7 | 58.6 | 56.1 | 176.0 | 341.4 | 874.2 | 558.3 | 161.0 | 79.2 | 60.6 |
| 1930 | 70.6 | 49.1 | 109.1 | 55.5 | 172.0 | 262.7 | 864.2 | 606.4 | 302.4 | 120.3 | 66.0 | 63.9 |
| 1931 | 90.4 | 101.6 | 72.4 | 97.5 | 102.9 | 302.8 | 578.9 | 813.2 | 243.0 | 95.4 | 58.2 | 60.5 |
| 1932 | 64.9 | 75.7 | 79.5 | 80.0 | 95.3 | 386.5 | 947.2 | 1645.5 | 762.2 | 211.6 | 93.9 | 66.9 |
| 1933 | 79.3 | 184.1 | 138.8 | 144.6 | 80.4 | 214.1 | 682.2 | 1047.5 | 1423.3 | 277.3 | 105.1 | 91.2 |
| 1934 | 209.7 | 316.7 | 1125.1 | 852.6 | 425.8 | 898.1 | 1249.0 | 688.6 | 245.1 | 104.4 | 64.4 | 59.7 |
| 1935 | 100.2 | 167.2 | 138.6 | 134.8 | 127.0 | 250.4 | 624.0 | 1104.0 | 576.5 | 175.9 | 81.5 | 57.7 |
| 1936 | 62.5 | 58.1 | 61.9 | 93.6 | 63.2 | 217.9 | 1133.1 | 1390.2 | 428.6 | 133.8 | 69.0 | 60.4 |
| 1937 | 54.6 | 47.6 | 67.6 | 42.2 | 50.0 | 123.8 | 418.6 | 940.8 | 488.1 | 147.4 | 77.4 | 55.1 |
| 1938 | 58.9 | 110.9 | 153.5 | 155.4 | 121.3 | 357.0 | 899.9 | 1070.1 | 558.6 | 168.7 | 85.1 | 63.8 |
| 1939 | 78.9 | 87.4 | 116.3 | 100.3 | 76.5 | 286.3 | 757.4 | 954.8 | 329.6 | 134.6 | 66.8 | 57.5 |
| 1940 | 66.7 | 60.8 | 144.4 | 135.7 | 250.6 | 490.2 | 692.3 | 749.1 | 286.8 | 102.9 | 60.2 | 62.2 |
| 1941 | 85.1 | 101.6 | 178.3 | 155.2 | 134.1 | 240.2 | 343.6 | 526.0 | 349.2 | 130.3 | 77.2 | 110.7 |
| 1942 | 139.5 | 214.8 | 374.6 | 181.7 | 141.8 | 192.6 | 617.3 | 527.9 | 392.1 | 191.0 | 86.2 | 66.7 |
| 1943 | 66.3 | 182.6 | 171.2 | 175.1 | 132.8 | 299.6 | 1187.5 | 1126.0 | 1014.8 | 400.7 | 117.8 | 73.7 |
| 1944 | 85.1 | 84.5 | 115.8 | 69.0 | 89.8 | 118.0 | 422.4 | 601.1 | 311.5 | 123.9 | 72.6 | 62.9 |
| 1945 | 66.5 | 79.5 | 77.0 | 196.8 | 179.1 | 208.2 | 410.0 | 1130.2 | 544.4 | 170.4 | 80.7 | 82.2 |
| 1946 | 80.8 | 168.6 | 196.6 | 213.9 | 128.3 | 377.4 | 808.6 | 1105.4 | 560.3 | 238.6 | 101.3 | 84.3 |
| 1947 | 148.3 | 213.9 | 612.7 | 246.1 | 318.4 | 450.8 | 731.5 | 1243.5 | 548.9 | 188.8 | 97.6 | 92.0 |
| 1948 | 200.3 | 228.4 | 225.7 | 322.4 | 234.4 | 264.0 | 781.6 | 1747.9 | 1112.8 | 275.1 | 153.2 | 93.4 |
| 1949 | 95.2 | 124.8 | 99.2 | 84.8 | 128.7 | 395.5 | 996.3 | 1680.2 | 621.9 | 192.6 | 91.0 | 75.5 |
| 1950 | 96.2 | 132.5 | 134.3 | 135.9 | 183.9 | 424.3 | 851.1 | 1279.0 | 1407.1 | 496.8 | 154.6 | 96.6 |
| 1951 | 183.2 | 276.7 | 377.2 | 273.5 | 423.5 | 279.3 | 920.7 | 1105.8 | 568.6 | 218.9 | 98.2 | 78.5 |
| 1952 | 193.4 | 158.6 | 199.0 | 117.0 | 151.1 | 192.1 | 932.4 | 1264.7 | 565.5 | 213.9 | 94.4 | 69.5 |
| 1953 | 58.6 | 55.8 | 63.7 | 260.2 | 276.2 | 251.8 | 513.3 | 938.2 | 896.6 | 278.0 | 105.5 | 68.1 |
| 1954 | 63.2 | 88.6 | 135.9 | 125.5 | 232.0 | 296.0 | 795.2 | 1399.2 | 901.7 | 405.9 | 144.1 | 105.0 |
| 1955 | 105.0 | 126.1 | 109.7 | 99.8 | 93.6 | 100.2 | 386.2 | 1104.0 | 1085.2 | 412.7 | 130.8 | 93.6 |
| 1956 | 142.2 | 245.4 | 467.8 | 297.6 | 162.9 | 327.8 | 1138.1 | 1657.8 | 826.0 | 285.9 | 124.3 | 88.9 |
| 1957 | 102.8 | 122.8 | 192.8 | 109.9 | 162.3 | 381.1 | 743.5 | 1528.9 | 698.4 | 195.2 | 99.5 | 68.8 |
| 1958 | 83.9 | 80.5 | 110.4 | 108.6 | 305.5 | 262.1 | 729.8 | 1344.2 | 533.5 | 166.6 | 87.4 | 83.5 |
| 1959 | 124.3 | 366.6 | 452.0 | 489.8 | 248.5 | 329.8 | 826.7 | 1114.5 | 949.2 | 257.2 | 107.2 | 174.7 |
| 1960 | 358.6 | 405.4 | 270.0 | 169.9 | 204.7 | 424.0 | 809.4 | 934.0 | 763.1 | 202.4 | 110.1 | 77.3 |
| 1961 | 91.8 | 150.6 | 110.1 | 127.7 | 504.1 | 447.9 | 689.5 | 1206.0 | 825.0 | 174.8 | 81.1 | 81.6 |
| 1962 | 102.4 | 86.9 | 109.5 | 172.1 | 190.4 | 217.5 | 1025.6 | 1109.0 | 692.0 | 204.2 | 97.3 | 79.8 |
| 1963 | 172.9 | 222.6 | 274.7 | 164.7 | 391.4 | 334.0 | 483.0 | 724.1 | 432.2 | 160.1 | 81.6 | 71.8 |
| 1964 | 68.9 | 103.9 | 79.8 | 79.9 | 78.6 | 123.8 | 529.3 | 1191.0 | 1325.6 | 355.6 | 144.0 | 125.8 |
| 1965 | 124.4 | 177.0 | 610.8 | 396.6 | 369.9 | 379.9 | 1088.7 | 1184.9 | 789.4 | 240.5 | 132.9 | 107.3 |

Dworshak Reservoir (13340950)
Unregulated Monthly Inflow Volume in 1,000 acre-feet
Drainage Area: 2,440 square miles

| WATER YEAR | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1966 | 95.7 | 138.6 | 115.7 | 141.5 | 90.7 | 298.2 | 699.8 | 823.4 | 456.7 | 165.1 | 81.2 | 57.1 |
| 1967 | 75.7 | 124.2 | 203.2 | 293.3 | 245.2 | 288.8 | 426.1 | 1047.8 | 965.8 | 248.8 | 90.5 | 67.9 |
| 1968 | 125.0 | 154.5 | 136.5 | 147.2 | 522.3 | 496.2 | 415.2 | 760.5 | 611.5 | 183.3 | 107.2 | 145.5 |
| 1969 | 216.0 | 283.1 | 225.8 | 386.1 | 176.2 | 308.1 | 991.4 | 1178.0 | 525.6 | 178.9 | 88.5 | 73.0 |
| 1970 | 95.8 | 77.1 | 113.2 | 255.7 | 275.4 | 291.6 | 359.1 | 1052.5 | 976.3 | 229.9 | 103.3 | 95.6 |
| 1971 | 96.7 | 183.6 | 186.8 | 307.1 | 489.6 | 334.7 | 722.1 | 1820.7 | 1118.3 | 384.9 | 136.1 | 98.6 |
| 1972 | 96.7 | 98.6 | 91.5 | 189.6 | 258.3 | 1050.9 | 754.1 | 1954.1 | 1531.3 | 430.6 | 166.7 | 95.7 |
| 1973 | 87.8 | 88.9 | 208.1 | 247.0 | 120.8 | 219.2 | 302.3 | 584.7 | 334.2 | 105.5 | 58.5 | 67.2 |
| 1974 | 92.2 | 237.2 | 317.8 | 754.9 | 356.2 | 511.3 | 1000.7 | 1284.5 | 1873.6 | 491.5 | 141.0 | 75.0 |
| 1975 | 68.4 | 63.9 | 70.8 | 143.6 | 99.2 | 237.6 | 393.3 | 1120.7 | 1256.3 | 446.7 | 160.5 | 90.6 |
| 1976 | 151.5 | 208.9 | 525.4 | 320.3 | 234.3 | 284.6 | 794.2 | 1503.1 | 779.3 | 284.0 | 147.4 | 74.2 |
| 1977 | 70.0 | 73.4 | 62.5 | 55.5 | 73.4 | 130.9 | 380.2 | 519.5 | 252.5 | 87.7 | 66.4 | 84.5 |
| 1978 | 98.0 | 177.3 | 629.0 | 225.9 | 247.3 | 512.9 | 653.4 | 835.5 | 660.3 | 249.9 | 108.9 | 55.1 |
| 1979 | 70.2 | 67.8 | 47.6 | 65.5 | 128.9 | 373.7 | 606.0 | 1345.4 | 578.2 | 161.7 | 75.2 | 49.0 |
| 1980 | 73.4 | 48.8 | 134.9 | 103.9 | 189.4 | 275.9 | 654.2 | 890.6 | 546.9 | 193.6 | 87.3 | 69.2 |
| 1981 | 66.8 | 113.7 | 405.6 | 310.0 | 390.9 | 303.5 | 525.8 | 710.9 | 674.4 | 249.3 | 100.2 | 32.9 |
| 1982 | 86.1 | 111.1 | 198.7 | 120.6 | 556.4 | 560.1 | 653.8 | 1233.3 | 1069.5 | 361.0 | 122.8 | 63.1 |
| 1983 | 112.9 | 109.7 | 157.1 | 239.8 | 324.7 | 551.0 | 440.3 | 815.4 | 591.5 | 275.5 | 113.9 | 56.7 |
| 1984 | 79.9 | 208.5 | 130.1 | 261.8 | 226.3 | 467.9 | 622.2 | 965.0 | 900.9 | 274.3 | 98.6 | 60.6 |
| 1985 | 91.6 | 170.0 | 105.7 | 63.5 | 98.8 | 188.0 | 836.0 | 1196.4 | 769.0 | 144.4 | 78.7 | 135.1 |
| STATISTICS | | | | | | | | | | | | |
| N | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 |
| AVERAGE | 108.8 | 162.0 | 220.3 | 205.1 | 215.4 | 336.8 | 703.9 | 1108.7 | 732.0 | 231.6 | 100.3 | 80.0 |
| MAXIMUM | 358.6 | 1003.4 | 1125.1 | 852.6 | 556.4 | 1050.9 | 1249.0 | 1954.1 | 1873.6 | 496.8 | 166.7 | 174.7 |
| MINIMUM | 54.6 | 47.6 | 47.6 | 42.2 | 50.0 | 100.2 | 302.3 | 519.5 | 243.0 | 87.7 | 58.2 | 32.9 |

# TABLE 4-15

CLEARWATER RIVER AT OROFINO (13340000)
Monthly Discharge Volume in 1,000 acre-feet
Drainage Area: 5,580 square miles

| Water Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1931 | 143.4 | 123.0 | 97.7 | 120.6 | 113.1 | 317.5 | 758.1 | 1584.2 | 494.1 | 124.0 | 59.7 | 67.3 |
| 1932 | 72.7 | 86.4 | 93.8 | 91.0 | 115.5 | 509.6 | 1103.2 | 2517.7 | 1466.4 | 334.8 | 104.2 | 76.6 |
| 1933 | 99.2 | 216.1 | 156.1 | 168.7 | 104.1 | 291.8 | 815.8 | 1476.7 | 2728.7 | 397.8 | 110.0 | 90.5 |
| 1934 | 215.1 | 340.8 | 659.7 | 676.3 | 411.3 | 899.1 | 1664.6 | 1108.8 | 383.8 | 123.5 | 61.4 | 54.8 |
| 1935 | 100.5 | 175.8 | 143.9 | 135.3 | 139.1 | 269.2 | 744.1 | 1572.3 | 1024.8 | 256.4 | 85.5 | 59.4 |
| 1936 | 70.9 | 71.5 | 69.1 | 101.0 | 81.1 | 331.1 | 1666.5 | 2422.4 | 741.9 | 176.4 | 76.2 | 65.2 |
| 1937 | 60.8 | 55.0 | 72.3 | 49.2 | 57.2 | 145.4 | 409.8 | 1577.8 | 914.3 | 212.4 | 82.6 | 55.4 |
| 1938 | 68.0 | 97.0 | 173.4 | 171.9 | 145.8 | 399.2 | 1152.9 | 1897.6 | 1287.9 | 276.0 | 95.3 | 65.7 |
| 1965 | 156.1 | 199.4 | 542.5 | 545.4 | 543.5 | 442.1 | 1370.5 | 1984.3 | 1813.7 | 448.3 | 176.0 | 189.2 |
| 1966 | 155.1 | 178.9 | 140.9 | 151.8 | 119.2 | 387.5 | 883.1 | 1433.7 | 845.7 | 225.4 | 85.1 | 74.9 |
| 1967 | 101.8 | 130.8 | 180.1 | 275.1 | 227.7 | 339.6 | 523.8 | 1867.5 | 2098.5 | 427.9 | 101.0 | 64.6 |
| 1968 | 195.3 | 309.3 | 257.7 | 247.7 | 600.7 | 588.0 | 630.9 | 1479.3 | 1496.7 | 360.6 | 162.5 | 283.0 |
| 1969 | 326.2 | 461.2 | 328.3 | 603.3 | 270.9 | 454.2 | 1361.3 | 2152.5 | 1079.8 | 365.7 | 105.3 | 85.0 |
| 1970 | 137.9 | 123.1 | 144.4 | 392.4 | 351.5 | 370.6 | 485.8 | 1902.7 | 2102.1 | 493.7 | 128.1 | 147.9 |
| 1971 | 162.4 | 221.1 | 215.9 | 386.9 | 682.8 | 420.7 | 892.8 | 2663.4 | 2125.9 | 578.4 | 143.2 | 101.2 |
| 1972 | 97.2 | 115.3 | 115.5 | 186.1 | 361.5 | 1223.0 | 943.9 | 2679.1 | 2767.0 | 673.0 | 158.8 | 103.1 |
| 1973 | 99.7 | 106.8 | 213.8 | 194.0 | 122.4 | 234.5 | 380.3 | 1149.8 | 778.5 | 210.6 | 76.9 | 81.1 |
| 1974 | 91.0 | 248.3 | 305.9 | 483.9 | 343.3 | 552.4 | 1146.5 | 1800.8 | 3159.5 | 687.6 | 177.2 | 96.6 |
| 1975 | 75.6 | 88.0 | 88.4 | 180.9 | 135.4 | 304.8 | 503.8 | 1713.0 | 2806.3 | 1119.4 | 276.5 | 177.5 |
| 1976 | 282.7 | 341.4 | 870.5 | 521.3 | 317.9 | 385.4 | 1147.5 | 2762.4 | 1860.3 | 682.5 | 227.0 | 149.3 |
| 1977 | 128.3 | 124.6 | 104.9 | 102.2 | 110.2 | 164.4 | 640.2 | 1051.9 | 607.8 | 173.3 | 95.2 | 129.0 |
| 1978 | 188.3 | 263.3 | 795.1 | 397.8 | 380.7 | 800.4 | 1222.6 | 1760.6 | 1794.3 | 704.4 | 192.9 | 154.5 |
| 1979 | 100.5 | 97.9 | 97.7 | 94.9 | 177.1 | 497.9 | 786.2 | 2174.3 | 1189.3 | 286.9 | 102.4 | 75.8 |
| 1980 | 87.2 | 79.3 | 145.6 | 147.0 | 195.8 | 323.3 | 881.2 | 1696.3 | 1272.4 | 444.0 | 132.9 | 152.9 |
| 1981 | 109.2 | 215.4 | 453.1 | 427.1 | 419.8 | 398.6 | 720.2 | 1423.0 | 1805.0 | 464.5 | 130.8 | 91.3 |
| 1982 | 113.0 | 137.0 | 218.6 | 198.0 | 550.2 | 642.3 | 862.5 | 2101.3 | 2348.9 | 881.2 | 193.9 | 129.8 |
| 1983 | 213.5 | 181.0 | 193.5 | 303.6 | 328.2 | 624.0 | 578.7 | 1340.3 | 1113.5 | 478.8 | 166.2 | 114.3 |
| 1984 | 123.3 | 212.7 | 124.4 | 361.3 | 276.9 | 694.6 | 999.2 | 1867.7 | 2212.4 | 601.2 | 152.0 | 148.7 |
| 1985 | 138.9 | 187.3 | 145.2 | 124.4 | 101.6 | 234.4 | 999.5 | 1807.0 | 1089.4 | 194.4 | 132.8 | 212.9 |
| STATISTICS | | | | | | | | | | | | |
| N | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 |
| AVERAGE | 135.0 | 178.9 | 246.5 | 270.3 | 268.4 | 456.7 | 906.0 | 1826.5 | 1565.8 | 427.7 | 130.7 | 113.7 |
| MAXIMUM | 326.2 | 461.2 | 870.5 | 676.3 | 682.8 | 1223.0 | 1666.5 | 2762.4 | 3159.5 | 1119.4 | 276.5 | 283.0 |
| MINIMUM | 60.8 | 55.0 | 69.1 | 49.2 | 57.2 | 145.4 | 380.3 | 1051.9 | 383.8 | 123.5 | 59.7 | 54.8 |

# TABLE 4-16

CLEARWATER RIVER AT SPALDING (13342500)
Unregulated Monthly Discharge Volume in 1,000 acre-feet
Drainage Area: 9,570 square miles

| Water Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1911 | 283.7 | 644.9 | 456.7 | 270.9 | 267.4 | 681.5 | 1350.8 | 2485.1 | 2324.9 | 723.0 | 262.2 | 224.3 |
| 1912 | 274.0 | 341.5 | 244.5 | 457.7 | 714.6 | 441.3 | 1980.5 | 3994.4 | 3598.5 | 952.4 | 263.4 | 266.7 |
| 1913 | 218.9 | 390.7 | 267.9 | 319.1 | 339.5 | 679.1 | 2541.9 | 3835.1 | 3383.9 | 1056.1 | 305.5 | 204.2 |
| 1926 | 202.5 | 215.6 | 420.1 | 270.5 | 584.9 | 837.6 | 1884.1 | 1920.0 | 669.7 | 250.7 | 155.6 | 227.5 |
| 1927 | 422.5 | 683.5 | 1007.1 | 624.5 | 764.5 | 853.5 | 1555.5 | 3264.4 | 3853.5 | 860.1 | 280.7 | 333.7 |
| 1928 | 650.3 | 2317.1 | 1447.2 | 1353.7 | 757.5 | 1620.2 | 1777.4 | 4865.7 | 1792.7 | 617.9 | 231.1 | 171.1 |
| 1929 | 252.4 | 193.6 | 165.5 | 148.8 | 128.3 | 446.5 | 905.4 | 2460.5 | 1957.9 | 503.4 | 176.9 | 124.0 |
| 1930 | 140.4 | 121.4 | 267.6 | 128.1 | 431.6 | 673.8 | 2039.8 | 1877.8 | 1125.4 | 329.0 | 154.5 | 145.6 |
| 1931 | 237.2 | 232.4 | 175.9 | 233.2 | 241.5 | 742.3 | 1500.1 | 2300.1 | 770.6 | 226.4 | 119.0 | 128.7 |
| 1932 | 142.2 | 170.1 | 184.0 | 189.5 | 250.2 | 1265.2 | 2276.9 | 4396.6 | 2295.3 | 575.1 | 205.4 | 149.5 |
| 1933 | 185.4 | 430.9 | 313.6 | 316.4 | 188.9 | 689.5 | 1655.4 | 2631.5 | 4372.8 | 722.5 | 220.4 | 186.0 |
| 1934 | 446.9 | 690.1 | 2044.5 | 1751.2 | 885.2 | 1973.6 | 3074.6 | 1896.8 | 640.0 | 238.9 | 125.7 | 113.5 |
| 1935 | 202.6 | 351.1 | 310.8 | 317.4 | 322.6 | 631.3 | 1492.0 | 2716.2 | 1639.0 | 437.7 | 173.2 | 115.5 |
| 1936 | 136.0 | 131.0 | 135.8 | 223.7 | 162.5 | 725.5 | 2997.0 | 3936.5 | 1228.8 | 313.0 | 147.1 | 126.2 |
| 1937 | 118.6 | 106.1 | 143.7 | 97.0 | 114.8 | 362.5 | 985.2 | 2580.7 | 1425.7 | 361.6 | 164.2 | 111.3 |
| 1938 | 126.5 | 205.4 | 344.8 | 376.3 | 329.4 | 940.4 | 2168.8 | 3011.3 | 1841.3 | 454.1 | 186.1 | 130.0 |
| 1939 | 173.2 | 207.6 | 269.9 | 240.2 | 199.2 | 893.5 | 1894.2 | 2801.1 | 974.1 | 375.4 | 143.0 | 117.9 |
| 1940 | 142.1 | 136.2 | 285.8 | 323.0 | 657.0 | 1128.0 | 1808.4 | 2274.3 | 913.5 | 243.1 | 120.2 | 135.2 |
| 1941 | 230.4 | 262.0 | 427.1 | 375.3 | 315.6 | 519.1 | 885.2 | 1526.9 | 1147.5 | 392.3 | 184.2 | 303.4 |
| 1942 | 426.1 | 607.1 | 866.7 | 394.6 | 376.8 | 535.9 | 1745.1 | 1890.5 | 1500.9 | 583.4 | 203.1 | 150.7 |
| 1943 | 142.0 | 390.8 | 460.1 | 458.5 | 446.0 | 883.5 | 3175.6 | 3155.6 | 3200.2 | 1285.6 | 288.1 | 170.8 |
| 1944 | 180.5 | 209.2 | 226.0 | 158.4 | 201.6 | 327.6 | 1086.3 | 1910.9 | 1193.7 | 394.9 | 182.0 | 140.6 |
| 1945 | 143.7 | 174.1 | 168.3 | 405.0 | 416.9 | 539.4 | 1020.1 | 3208.5 | 1941.3 | 517.7 | 173.3 | 180.6 |
| 1946 | 189.1 | 409.2 | 476.5 | 539.4 | 357.9 | 1065.3 | 2111.6 | 2990.1 | 1575.7 | 597.8 | 221.6 | 208.4 |
| 1947 | 405.2 | 530.2 | 1448.4 | 610.1 | 795.9 | 1037.4 | 1840.3 | 3849.6 | 1823.0 | 592.3 | 223.9 | 199.7 |
| 1948 | 418.5 | 545.0 | 630.3 | 814.5 | 651.5 | 749.0 | 2046.6 | 5281.9 | 3826.2 | 763.9 | 362.2 | 198.7 |
| 1949 | 212.7 | 301.2 | 261.2 | 226.7 | 378.1 | 1222.8 | 2438.3 | 4670.9 | 1867.9 | 512.5 | 197.6 | 156.5 |
| 1950 | 216.1 | 342.5 | 370.8 | 357.1 | 635.9 | 1259.9 | 2077.5 | 3164.9 | 3945.0 | 1340.5 | 380.0 | 204.8 |
| 1951 | 415.4 | 662.2 | 840.1 | 653.8 | 1042.4 | 716.2 | 2184.2 | 3270.2 | 1846.2 | 668.1 | 220.0 | 158.2 |
| 1952 | 378.4 | 322.3 | 386.5 | 254.7 | 390.5 | 586.2 | 2410.7 | 3789.5 | 1823.4 | 562.5 | 207.4 | 142.0 |
| 1953 | 116.4 | 115.5 | 130.7 | 539.1 | 613.9 | 602.1 | 1232.1 | 2435.1 | 2923.7 | 828.7 | 231.4 | 132.9 |
| 1954 | 130.1 | 184.8 | 288.7 | 278.9 | 536.3 | 616.8 | 1729.0 | 3537.4 | 2419.3 | 1071.1 | 317.4 | 213.1 |
| 1955 | 210.1 | 241.4 | 211.0 | 202.2 | 196.9 | 237.8 | 1117.9 | 2914.6 | 3403.7 | 1239.3 | 301.4 | 190.3 |
| 1956 | 284.8 | 561.1 | 1070.9 | 750.9 | 407.5 | 1077.0 | 2858.6 | 4394.4 | 2334.4 | 669.7 | 261.9 | 182.2 |
| 1957 | 224.9 | 293.3 | 444.5 | 246.5 | 405.2 | 1082.6 | 1724.5 | 4457.7 | 2230.2 | 525.3 | 209.5 | 145.4 |
| 1958 | 187.8 | 185.3 | 269.5 | 262.1 | 746.3 | 576.9 | 1731.4 | 3600.8 | 1525.3 | 450.5 | 195.0 | 180.2 |
| 1959 | 278.6 | 801.6 | 1155.0 | 1175.8 | 699.8 | 923.3 | 2019.6 | 3023.3 | 3031.2 | 714.4 | 236.8 | 382.8 |
| 1960 | 1055.4 | 993.6 | 643.8 | 404.0 | 583.1 | 1127.3 | 2091.2 | 2546.2 | 2389.3 | 519.8 | 235.0 | 159.6 |

# TABLE 4-16

CLEARWATER RIVER AT SPALDING (13342500)
Unregulated Monthly Discharge Volume in 1,000 Acre-feet
Drainage Area: 9,570 Square Miles

| Water Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1961 | 183.4 | 309.0 | 246.4 | 281.8 | 1073.5 | 1005.4 | 1568.4 | 3154.4 | 2412.7 | 401.2 | 163.1 | 185.8 |
| 1962 | 271.1 | 217.9 | 281.3 | 486.9 | 513.1 | 615.3 | 2388.9 | 2926.7 | 2135.0 | 532.4 | 215.0 | 160.1 |
| 1963 | 403.4 | 549.5 | 697.7 | 361.8 | 945.7 | 838.0 | 1272.8 | 2455.4 | 1690.3 | 540.6 | 204.3 | 164.1 |
| 1964 | 149.8 | 225.2 | 196.4 | 202.1 | 202.9 | 352.2 | 1295.6 | 3246.2 | 4381.2 | 1109.1 | 362.2 | 326.2 |
| 1965 | 284.0 | 383.7 | 1319.0 | 1123.1 | 1042.3 | 880.0 | 2632.5 | 3283.1 | 2732.1 | 725.0 | 324.1 | 300.1 |
| 1966 | 257.6 | 320.5 | 263.6 | 307.9 | 226.8 | 785.6 | 1624.5 | 2342.9 | 1337.9 | 399.8 | 172.3 | 140.5 |
| 1967 | 186.7 | 259.7 | 394.4 | 632.1 | 501.5 | 680.9 | 1022.5 | 2985.0 | 3071.1 | 694.4 | 198.7 | 134.8 |
| 1968 | 323.5 | 468.5 | 419.0 | 409.9 | 1234.6 | 1105.4 | 1063.0 | 2285.8 | 2138.4 | 548.8 | 276.3 | 429.0 |
| 1969 | 538.2 | 746.4 | 584.3 | 1133.1 | 477.4 | 946.8 | 2550.0 | 3385.0 | 1619.7 | 555.3 | 201.6 | 160.1 |
| 1970 | 238.3 | 206.5 | 265.9 | 750.1 | 716.6 | 740.4 | 904.5 | 2953.4 | 3095.6 | 722.5 | 236.0 | 249.9 |
| 1971 | 269.1 | 409.5 | 409.1 | 807.9 | 1227.4 | 831.3 | 1696.3 | 4488.9 | 3303.5 | 966.8 | 276.7 | 193.5 |
| 1972 | 195.4 | 218.4 | 223.3 | 469.4 | 871.3 | 2648.0 | 1829.8 | 4576.1 | 4257.0 | 1135.2 | 313.0 | 196.5 |
| 1973 | 183.4 | 195.7 | 407.5 | 479.7 | 246.3 | 491.6 | 690.1 | 1714.9 | 1093.5 | 318.9 | 121.9 | 149.5 |
| 1974 | 175.3 | 501.6 | 736.6 | 1458.5 | 826.1 | 1333.5 | 2423.6 | 3272.0 | 5310.0 | 1182.1 | 306.6 | 165.0 |
| 1975 | 140.3 | 162.8 | 169.8 | 350.0 | 296.4 | 746.6 | 1067.9 | 3075.6 | 4313.9 | 1639.4 | 424.1 | 264.4 |
| 1976 | 441.1 | 574.5 | 1520.0 | 965.0 | 652.2 | 800.7 | 2119.2 | 4367.5 | 2664.8 | 964.0 | 382.2 | 219.5 |
| 1977 | 202.3 | 199.6 | 176.6 | 173.4 | 203.3 | 295.2 | 1011.8 | 1549.3 | 853.0 | 258.5 | 203.2 | 218.5 |
| 1978 | 292.4 | 440.9 | 1496.6 | 700.2 | 717.3 | 1375.4 | 1886.9 | 2580.9 | 2399.0 | 933.9 | 301.7 | 221.2 |
| 1979 | 175.4 | 171.2 | 166.1 | 177.1 | 380.8 | 1064.2 | 1509.6 | 3601.0 | 1733.2 | 446.3 | 182.6 | 132.1 |
| 1980 | 168.1 | 133.1 | 301.9 | 276.0 | 463.5 | 679.2 | 1521.2 | 2564.1 | 1791.7 | 619.1 | 214.2 | 209.8 |
| 1981 | 171.1 | 315.9 | 857.1 | 754.1 | 898.9 | 719.4 | 1264.4 | 2135.4 | 2532.1 | 719.1 | 236.7 | 134.9 |
| 1982 | 216.7 | 260.7 | 452.1 | 387.9 | 1391.0 | 1384.1 | 1620.1 | 3337.6 | 3405.1 | 1209.9 | 315.0 | 193.4 |
| 1983 | 326.9 | 306.2 | 391.1 | 608.7 | 769.2 | 1289.3 | 1099.5 | 2178.5 | 1718.9 | 759.6 | 288.4 | 176.7 |
| 1984 | 221.1 | 449.0 | 311.6 | 707.1 | 591.8 | 1359.4 | 1702.0 | 2889.6 | 3220.6 | 873.8 | 263.1 | 217.9 |
| 1985 | 234.7 | 369.7 | 269.4 | 201.9 | 220.6 | 524.5 | 1979.5 | 3021.3 | 1855.4 | 351.1 | 215.4 | 347.7 |
| STATISTICS | | | | | | | | | | | | |
| N | 63 | 63 | 63 | 63 | 63 | 63 | 63 | 63 | 63 | 63 | 63 | 63 |
| AVERAGE | 261.1 | 382.5 | 505.1 | 491.3 | 543.3 | 869.3 | 1764.4 | 3067.3 | 2314.6 | 667.9 | 232.8 | 192.1 |
| MAXIMUM | 1055.4 | 2317.1 | 2044.5 | 1751.2 | 1391.0 | 2648.0 | 3175.6 | 5281.9 | 5310.0 | 1639.4 | 424.1 | 429.0 |
| MINIMUM | 116.4 | 106.1 | 130.7 | 97.0 | 114.8 | 237.8 | 690.1 | 1526.9 | 640.0 | 226.4 | 119.0 | 111.3 |

# TABLE 4-19

MAXIMUM AND MINIMUM SECCHI DICS READINGS IN FEET
North Fork Clearwater River - Dworshak Reservoir

| Year | RM 3 Max | RM 3 Min | RM 19 Max | RM 19 Min | RM 35 Max | RM 35 Min | EC 4 Max | EC 4 Min | LNFK 1 Max | LNFK 1 Min |
|---|---|---|---|---|---|---|---|---|---|---|
| 1972 | 20.3 (29 Nov) | 2.1 (19 Jun) | 16.0 (7 Sep) | 3.5 (13 Apr) | 14.0 (18 Nov) | 5.7 (5 Jul) | 17.7 (7 Sep) | 3.3 (6 Jul) | 10.3 (1 Dec) | * |
| 1973 | 18.0 (26 Jul) | 5.1 (3 May) | 16.0 (5 Sep) | 6.7 (2 May) | 14.5 (9 Sep) | 6.9 (11 Mar) | 22.5 (27 Jul) | 6.2 (2 May) | 12.0 (14 Jul) | 5.0 (17 Nov) |
| 1974 | 26.0 (16 Jul) | 4.0 (13 Mar) | 21.0 (7 Aug) | 2.1 (3 Apr) | 25.0 (8 Aug) | 2.0 (2 Apr) | 23.0 (20 Aug) | 2.3 (3 Apr) | 21.0 (7 Aug) | 1.8 (2 Apr) |
| 1975 | 12.8 (9 Dec) | 9.0 (11 Mar) | 13.1 (20 Aug) | 6.0 (12 Mar) | NM | NM | * | 6.7 (12 Mar) | NM | NM |
| 1976 | 20.7 (16 Sep) | 6.8 (11 Mar) | 14.9 (16 Sep) | * | 27.5 (14 Sep) | * | 19.6 (16 Sep) | 5.3 (11 Mar) | 26.9 (14 Sep) | * |
| 1977 | 21.9 (4 Oct) | 6.0 (17 May) | 16.0 (20 Jul) | 4.5 (17 May) | 13.2 (16 Mar) | * | 14.5 (20 Aug) | 4.0 (17 May) | 9.9 (5 Oct) | * |
| 1978 | 9.9 (17 Jul) | 6.2 (18 Apr) | 12.1 (16 Aug) | 5.9 (20 Apr) | 17.1 (17 Aug) | 8.1 (19 Apr) | 10.9 (16 Aug) | 5.7 (20 Apr) | 20.6 (17 Aug) | * |
| 1979 | 15.1 (14 Aug) | 4.6 (8 May) | 13.5 (15 Aug) | 4.9 (25 Apr) | 13.8 (26 Jun) | 5.5 (24 Apr) | 16.4 (15 Aug) | 3.5 (25 Apr) | * | 5.3 (24 Apr) |
| 1980 | 17.1 (7 Oct) | 4.6 (8 May) | 18.8 (12 Aug) | 9.2 (18 Jun) | 21.1 (8 Oct) | 11.0 (17 Jun) | 16.3 (8 Oct) | 6.5 (18 Jun) | 17.1 (8 Oct) | * |
| 1981 | 22.2 (23 Aug) | 9.4 (21 Jun) | 17.5 (28 Oct) | 7.1 (14 May) | 17.5 (28 Jul) | 9.1 (14 May) | 15.2 (27 Oct) | 4.9 (14 May) | 17.3 (28 July) | 7.8 (14 May) |
| 1982 | 11.5 (26 Jul) | 5.4 (24 May) | * | 3.2 (29 Apr) | 15.5 (29 Jun) | 6.1 (29 Apr) | * | 4.4 (29 Apr) | 10.9 (29 Jun) | * |
| 1983 | 21.75 (23 Aug) | 12.0 (21 Jun) | 16.3 (29 Sep) | * | 18.9 (29 Sep) | * | 15.0 (29 Sep) | * | 16.5 (29 Sep) | * |
| 1984 | 17.7 (15 Aug) | * | NM | NM | NM | NM | NM | NM | NM | NM |

* Data not available because of limited sampling record.
NM Not measured.

RM 3 - North Fork Clearwater River Mile 3.
RM 19 - North Fork Clearwater River Mile 19.
RM 35 - North Fork Clearwater River Mile 35.
EC 4 - Elk Creek Mile 4.
LNFK 1 - Little North Fork Clearwater River Mile 1.

Source of Data: Corps of Engineers, Walla Walla District, Environmental Resources Branch, March 1986

# TABLE 4-20

AVERAGE MONTHLY WATER TEMPERATURES

CLEARWATER RIVER NEAR OROFINO, RM 41.0

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1972 | 33.1 | 34.2 | 39.6 | 42.9 | 45.7 | 49.4 | 59.5 | 71.1 | 60.4 | 49.1 | 39.9 | ++++ |
| 1973 | ++++ | 35.8 | 41.3 | 47.4 | 49.9 | 56.9 | 73.3 | 74.3 | 63.3 | 50.3 | 38.2 | 35.5 |
| 1974 | ++++ | ++++ | 41.8 | 44.7 | 47 | 51.1 | 66.3 | 72.6 | 63.2 | 49.3 | 41.6 | 34.7 |
| 1975 | 33.1 | 34.4 | 40.1 | 43.1 | 45.3 | 47.2 | 62.9 | 65.9 | 60.7 | 48.6 | 36.9 | 35.9 |
| 1976 | 35.0 | 35.3 | 38.2 | 42.8 | 45.8 | 49.5 | 63.6 | 66.9 | 62.6 | 49.5 | 40.8 | 32.1 |
| 1977 | 32.0 | 34.5 | 41.7 | 47.3 | 50.7 | 64.8 | 71.6 | 73.8 | 62.7 | 50.1 | 39.1 | ++++ |
| 1978 | 39.2 | 40.2 | 43.6 | 46.6 | 48.6 | 53.7 | 66.0 | 69.9 | 62.0 | 50.5 | 37.7 | 34.9 |
| 1979 | 34.2 | 36.0 | 42.2 | 47.7 | 49.9 | 56.8 | 66.0 | 69.9 | 62.0 | * | * | * |
| 1980 | * | * | * | * | * | * | * | * | * | * | * | * |

N.F. CLEARWATER RIVER AT DWORSHAK DAM - STATION ESTABLISHED 9 FEB 1972

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1972 | | | 36.3 | 40.2 | 42.7 | 46.2 | 47.5 | 48.4 | 48.3 | 48.2 | 47.8 | 46.4 |
| 1973 | 43.5 | 42.3 | 42.0 | 41.6 | 41.8 | 42.1 | 42.2 | 54.3 | 53.7 | 54.9 | 48.3 | 44.2 |
| 1974 | 40.7 | 39.3 | 39.2 | 40.5 | 44.7 | 47.6 | 53.0 | 61.3 | 58.9 | 50.0 | 45.4 | 44.0 |
| 1975 | 41.9 | 40.4 | 40.3 | 40.8 | 41.2 | 43.7 | 53.4 | 57.5 | 56.2 | ++++ | 43.0 | 41.7 |
| 1976 | 39.7 | 37.0 | 37.3 | 39.3 | 43.8 | 47.6 | 51.9 | 54.9 | 56.1 | 53.1 | 47.6 | 42.2 |
| 1977 | 39.9 | 39.3 | 39.7 | 40.3 | 47.0 | 50.0 | 49.6 | 48.3 | 49.4 | 53.0 | 45.7 | 39.8 |
| 1978 | 38.6 | 37.6 | 38.8 | 41.4 | 44.8 | 47.7 | 51.2 | 52.6 | 54.9 | 53.7 | 45.7 | 40.6 |
| 1979 | 37.5 | 36.9 | 37.6 | 40.6 | 44.8 | 48.9 | 49.8 | 49.6 | 49.0 | 50.4 | 47.8 | 41.3 |
| 1980 | 39.9 | 38.5 | 38.7 | 40.6 | 46.2 | 47.8 | 47.5 | 46.2 | 49.5 | 49.4 | 48.0 | 42.7 |

CLEARWATER RIVER NEAR PECK RM 37.4 - STATION ESTABLISHED 13 JAN 1972

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1972 | | 34.5 | 37.9 | 41.6 | 45.1 | 47.2 | 57.0 | 62.5 | 53.3 | 48.6 | 43.7 | 40.0 |
| 1973 | 37.4 | 37.0 | 41.2 | 46.1 | 49.2 | 53.4 | 57.5 | 61.0 | 53.9 | 53.8 | 42.6 | 41.0 |
| 1974 | 38.6 | 39.0 | 40.0 | 43.2 | 45.2 | 50.2 | ++++ | 66.0 | 60.5 | 50.3 | 45.1 | 41.4 |
| 1975 | 38.9 | 39.8 | ++++ | 42.9 | 44.7 | 46.6 | 60.4 | 63.2 | 58.0 | 50.1 | 40.8 | 39.1 |
| 1976 | 38.2 | 37.1 | 38.9 | 43.2 | 46.4 | 49.8 | 61.1 | 63.6 | 59.8 | 52.2 | 46.4 | 39.4 |
| 1977 | 37.9 | 37.5 | 40.1 | 44.7 | 47.8 | 59.4 | 59.2 | 59.3 | 58.1 | 50.0 | 41.4 | 37.4 |
| 1978 | 37.7 | 38.2 | 40.8 | 44.3 | 46.0 | 50.6 | 60.2 | 62.2 | 57.3 | 51.1 | 41.5 | 39.5 |
| 1979 | 36.6 | 34.6 | 39.3 | 43.8 | 46.4 | 52.5 | 61.3 | 59.2 | 54.6 | 51.1 | 45.1 | 39.5 |
| 1980 | 37.0 | 36.4 | 40.2 | 44.5 | 47.4 | 50.9 | 61.0 | 58.0 | 54.1 | 51.1 | 43.1 | 38.6 |

* Temperature gage removed for construction of sewage treatment plant.

++++ Data missing, instrument malfunction

Source of Data: Corps of Engineers, Walla Walla District, Enviromental Resources Branch, May 1986.

SUMMARY FOR DWORSHAK DAILY SPILL IN CFS

| Water Year | October | | | November | | | December | | | January | | | February | | | March | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Maximum | Minimum | Average | Maximum | Minimum | Average | Maximum | Minimum | Average | Maximum | Minimum | Average | Maximum | Minimum | Average | Maximum | Minimum | Average |
| 1972 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17,900 (25 Mar) | 0 (1 Mar) | 9,481 |
| 1973 | 2,900 (14 Oct) | 1,000 (9 Oct) | 1,528 | 6,500 (29 Nov) | 1,200 (1 Nov) | 3,498 | 9,000 (11 Dec) | 600 (15 Dec) | 4,666 | 11,200 (20 Jan) | 1,700 (29 Jan) | 4,390 | 2,400 (4 Feb) | 700 (11 Feb) | 1,232 | 1,000 (1 Mar) | 0 (11 Mar) | 548 |
| 1974 | 0 | 0 | 0 | 100 (1 Nov) | 0 (2 Nov) | 3 | 0 | 0 | 0 | 25,700 (24 Jan) | 0 (1 Jan) | 8,939 | 16,200 (10 Feb) | 0 (12 Feb) | 6,929 | 11,800 (5 Mar) | 600 (31 Mar) | 7,381 |
| 1975 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18,300 (16 Feb) | 0 (1 Feb) | 4,686 | 7,900 (16 Mar) | 0 (25 Mar) | 3,390 |
| 1976 | 0 | 0 | 0 | 0 | 0 | 0 | 19,500 (13 Dec) | 0 (1 Dec) | 1,658 | 0 | 0 | 0 | 2,600 (28 Feb) | 0 (1 Feb) | 317 | 5,500 (23 Mar) | 0 (29 Mar) | 2,677 |
| 1977 | 300 (13 Oct) | 0 (1 Oct) | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1978 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1979 | 500 (18 Oct) | 0 (1 Oct) | 219 | 1,000 (7 Nov) | 0 (1 Nov) | 253 | 0 | 0 | 0 | 10,000 (6 Jan) | 0 (1 Jan) | 697 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1980 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1981 | 0 | 0 | 0 | 0 | 0 | 0 | 3,900 (28 Dec) | 0 (1 Dec) | 294 | 0 | 0 | 0 | 1,700 (2 Feb) | 0 (1 Feb) | 121 | 0 | 0 | 0 |
| 1982 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5,100 (27 Feb) | 0 (1 Feb) | 457 | 17,000 (23 Mar) | 3,000 (27 Mar) | 11,319 |
| 1983 | 0 | 0 | 0 | 200 (16 Nov) | 0 (1 Nov) | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4,900 (13 Mar) | 0 (1 Mar) | 3,026 |
| 1984 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1985 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Source: Corps of Engineer, Walla Walla District, Hydrology Branch.

## SUMMARY FOR DWORSHAK DAILY SPILL IN CFS

| Water Year | April | | | May | | | June | | | July | | | August | | | September | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Maximum | Minimum | Average | Maximum | Minimum | Average | Maximum | Minimum | Average | Maximum | Minimum | Average | Maximum | Minimum | Average | Maximum | Minimum | Average |
| 1972 | 16,700 (9 Apr) | 14,100 (27 Apr) | 15,603 | 25,900 (29 May) | 10,000 (31 May) | 20,100 | 18,500 (17 Jun) | 6,000 (6 Jun) | 11,580 | 12,400 (9 Jul) | 3,100 (31 Jul) | 6,621 | 3,600 (4 Aug) | 780 (20 Aug) | 2,296 | 2,200 (23 Sep) | 1,400 (9 Sep) | 1,629 |
| 1973 | 300 (26 Apr) | 0 (1 Apr) | 30 | 600 (13 May) | 0 (1 May) | 42 | 300 (12 Jun) | 0 (1 Jun) | 20 | 2,500 (18 Jul) | 0 (1 Jul) | 534 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1974 | 15,000 (30 Apr) | 0 (1 Apr) | 7,837 | 19,200 (7 May) | 0 (10 May) | 3,397 | 32,900 (18 Jun) | 0 (1 Jun) | 12,523 | 10,700 (2 Jul) | 1,000 (30 Jul) | 4,852 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1975 | 0 | 0 | 0 | 0 | 0 | 0 | 14,200 (27 Jun) | 0 (1 Jun) | 2,373 | 1,300 (1 Jul) | 0 (2 Jul) | 42 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1976 | 10,800 (12 Apr) | 0 (1 Apr) | 3,193 | 0 | 0 | 0 | 5,600 (18 Jun) | 0 (1 Jun) | 537 | 0 | 0 | 0 | 0 | 0 | 0 | 2,100 (23 Sep) | 0 (1 Sep) | 293 |
| 1977 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1978 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1980 | 0 | 0 | 0 | 0 | 0 | 0 | 7,100 (2 Jun) | 0 (14 Jun) | 1,193 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1981 | 0 | 0 | 0 | 6,500 (2 May) | 0 (5 May) | 726 | 7,600 (19 Jun) | 0 (2 Jun) | 2,133 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1982 | 4,200 (4 Apr) | 0 (8 Apr) | 740 | 1,200 (26 May) | 0 (1 May) | 465 | 10,000 (22 Jun) | 0 (2 Jun) | 4,217 | 10,000 (1 Jul) | 0 (31 Jul) | 4,639 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1983 | 4,000 (1 Apr) | 0 (7 Apr) | 717 | 6,800 (28 May) | 0 (1 May) | 432 | 7,000 (3 Jun) | 0 (1 Jun) | 1,863 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1984 | 0 | 0 | 0 | 0 | 0 | 0 | 8,800 (22 Jun) | 0 (1 Jun) | 5,177 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1985 | 5,400 (27 Apr) | 0 (1 Apr) | 753 | 5,300 (9 May) | 0 (2 May) | 1,835 | 17,500 (9 Jun) | 0 (1 Jun) | 2,723 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Source: Corps of Engineers, Walla Walla District, Hydrology Branch.

TABLE 6-1

RESERVOIR PROJECT DATA FOR COLUMBIA RIVER BASIN FLOOD CONTROL SYSTEM

| Project | River | Pool Elev, MSL Min | Pool Elev, MSL Max | Active Storage, Ac. Ft. Total 1/ | Active Storage, Ac. Ft. Committed for Flood Control | Project Owner |
|---|---|---|---|---|---|---|
| | CATEGORY I | | | | | |
| Mica | Columbia | 2320 | 2475 | 12,000,000 | 12,000,000 2/ | B.C. Hydro and Power Authority |
| Duncan | Duncan | 1792 | 1892 | 1,412,000 | 1,412,000 2/ | B.C. Hydro and Power Authority |
| Libby | Kootenai | 2287 | 2459 | 4,934,000 | 4,934,000 | U.S. Corps of Engineers |
| Hungry Horse | S. Fk. Flathead | 3336 | 3560 | 3,161,000 3/ | 2,980,000 4/ | U.S. Bureau of Reclamation |
| Noxon | Clark Fork | 2295 | 2331 | 231,000 | 5/ | Washington Water Power |
| Brownlee | Snake | 1976 | 2077 | 980,000 | 980,000 | Idaho Power Company |
| Dworshak | N. Fk. Clearwater | 1445 | 1600 | 2,016,000 | 2,016,000 | U.S. Corps of Engineers |
| | CATEGORY II | | | | | |
| Jackson Lake | Snake | 6730 | 6769 | 847,000 | 1,400,000 | U.S. Bureau of Reclamation |
| Palisades | Snake | 5497 | 5620 | 1,200,000 | | U.S. Bureau of Reclamation |
| Anderson Ranch | S. Fk. Boise | 4039.6 | 4196 | 423,000 | | U.S. Bureau of Reclamation |
| Arrowrock | Boise | 2967 | 3216 | 286,600 | 988,000 | U.S. Bureau of Reclamation |
| Lucky Peak | Boise | 2905 | 3060 | 278,200 | | U.S. Corps of Engineers |
| Cascade | N. Fk. Payette | 4787 | 4828 | 653,200 | 5/ | U.S. Bureau of Reclamation |
| Deadwood | Deadwood | 5203 | 5334 | 160,400 | 5/ | U.S. Bureau of Reclamation |
| 5 Yakima River Reservoirs | | -- | -- | 1,065,500 | 5/ | U.S. Bureau of Reclamation |
| | CATEGORY III | | | | | |
| Corra Linn Dam - Kootenay L. | Kootenay | 1738 | 1745.32 6/ | 787,000 | 7/ | W. Kootenay |
| Kerr Dam - Flathead L. | Flathead | 2883 | 2893 6/ | 1,219,000 | 7/ | Montana Power Co. |
| Albeni Falls Dam - Pend Oreille L. | Pend Oreille | 2049.7 | 2062.5 6/ | 1,155,000 | 7/ | U.S. Corps of Engineers |
| Post Falls Dam - Coeur d'Alene L. | Spokane | 2120.5 | 2128 6/ | 225,000 | 7/ | Washington Water Power |
| | CATEGORY IV | | | | | |
| Arrow | Columbia | 1377 | 1444 8/ | 7,145,000 | 7,145,000 2/, 9/ | B.C. Hydro and Power Authority |
| Grand Coulee | Columbia | 1208 | 1290 | 5,228,000 | 5,228,000 | U.S. Bureau of Reclamation |
| John Day | Columbia | 257 | 268 | 535,000 | 535,000 | U.S. Corps of Engineers |
| | CATEGORY V | | | | | |
| Chief Joseph | Columbia | 930 | 956 | 116,000 12/ | 10/ | U.S. Corps of Engineers |
| Wells | Columbia | 767 | 779 | 125,000 12/ | 125,000 11/ | Douglas County PUD |
| Rocky Reach | Columbia | 703 | 707 | 36,000 12/ | 120,000 11/ | Chelan County PUD |
| Wanapum | Columbia | 539 | 575 | 144,000 12/ ) | 500,000 | Grant County PUD |
| Priest Rapids | Columbia | 465.9 | 491.5 | 44,000 12/ ) | | Grant County PUD |
| McNary | Columbia | 335 | 340.5 | 205,000 12/ | 10/ | U.S. Corps of Engineers |
| The Dalles | Columbia | 155 | 160 | 53,000 12/ | 10/ | U.S. Corps of Engineers |
| Bonneville | Columbia | 70 | 74 | 87,000 12/ | 10/ | U.S. Corps of Engineers |
| Lower Granite | Snake | 733 | 738 | 53,000 12/ | 10/ | U.S. Corps of Engineers |
| Little Goose | Snake | 633 | 638 | 49,000 12/ | 10/ | U.S. Corps of Engineers |
| Lower Monumental | Snake | 537 | 540 | 20,000 12/ | 10/ | U.S. Corps of Engineers |
| Ice Harbor | Snake | 437 | 440 | 25,000 12/ | 10/ | U.S. Corps of Engineers |

1/ From best information available as of September 1982.

2/ Total of primary flood control and "on-call" storage.

3/ Reflects 6% of measured capacity to account for bank storage.

4/ Total measured capacity between pool limits, not including bank storage.

5/ Not committed but operated voluntarily by project owner for flood regulation.

6/ Controlled elevation for normal power operation. May be exceeded involuntarily during flood period.

7/ Normally operated to preserve natural lake storage during flood period.

8/ May be operated to El. 1446 under large flood.

9/ Includes involuntary storage.

10/ Pondage for re-regulation of floodflows.

11/ Maximum allowable for replacement of lost valley storage.

12/ Normal power pondage.

**TABLE 7-1**

PROJECT RELEASE LIMITATIONS

Maximum $\Delta$Q/60 min. at Dworshak to Limit of
1 ft/60 min. Change of Stage at Peck Gaging Station

| Increasing Releases (cfs) | | Decreasing Releases (cfs) | |
|---|---|---|---|
| Starting Peck Q | 60 min. $\Delta$Q DWO 1/ | Starting Peck Q | 60 min. $\Delta$Q DWO 1/ |
| 2,000- 3,000 | +1,700 | 3,500- 4,700 | -1,700 |
| 3,100- 5,000 | +2,200 | 4,800- 7,200 | -2,200 |
| 5,100- 7,000 | +2,700 | 7,300- 7,600 | -2,700 |
| 7,100- 9,000 | +3,100 | 9,700-11,900 | -3,100 |
| 9,100-11,000 | +3,500 | 12,000-14,400 | -3,500 |
| 11,100-13,000 | +4,000 | 14,500-16,900 | -4,000 |
| 13,100-15,000 | +4,400 | 17,000-19,000 | -4,400 |
| 15,100-17,000 | +4,800 | 19,100-21,400 | -4,800 |
| 17,100-19,000 | +5,000 | 21,500-23,500 | -5,000 |
| 19,100-24,000 | +5,200 | 23,600-28,800 | -5,200 |
| 24,100-28,000 | +5,600 | 28,900-33,200 | -5,600 |
| 28,100-33,000 | +6,100 | 33,300-38,700 | -6,100 |
| 33,100-44,000 | +6,600 | 38,800-50,200 | -6,600 |
| 49,100-57,000 | +7,200 | 50,300-63,700 | -7,200 |
| 57,100-78,000 | +7,700 | 63,800-85,200 | -7,700 |
| 78,100< | +8,300 | 85,200< | -8,300 |

1/ This table was developed from the Peck rating table and limited computer routings of DWO releases from power studies. This table should be checked by studies of actual project releases versus Peck flows.

# TABLE 8-1

DWORSHAK DAM
REGULATED MONTHLY DISCHARGE VOLUME IN 1,000 ACRE-FEET
DRAINAGE AREA: 2,440 SQUARE MILES

| Water Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | 93.9 | 208.2 | 286.9 | 270.0 | 68.4 | 66.1 | 74.0 | 111.7 | 108.9 | 210.6 | 181.7 | 364.6 |
| 1974 | 179.1 | 129.9 | 318.9 | 976.1 | 840.8 | 1016.1 | 999.7 | 428.4 | 941.4 | 475.8 | 152.1 | 303.1 |
| 1975 | 160.5 | 326.1 | 233.9 | 302.1 | 705.5 | 649.4 | 205.9 | 323.9 | 452.0 | 277.1 | 202.3 | 433.6 |
| 1976 | 218.4 | 349.3 | 676.6 | 634.3 | 622.0 | 785.1 | 443.3 | 169.0 | 461.8 | 280.9 | 146.6 | 319.1 |
| 1977 | 150.9 | 290.6 | 312.2 | 377.9 | 236.4 | 135.7 | 60.3 | 150.7 | 165.0 | 279.9 | 172.2 | 152.3 |
| 1978 | 123.4 | 293.8 | 347.1 | 625.2 | 591.5 | 631.1 | 63.1 | 134.9 | 377.7 | 226.5 | 172.6 | 371.3 |
| 1979 | 98.0 | 318.7 | 616.5 | 524.6 | 112.9 | 248.9 | 96.6 | 410.8 | 480.6 | 218.0 | 179.5 | 189.6 |
| 1980 | 163.4 | 291.6 | 455.8 | 377.5 | 141.4 | 137.7 | 208.3 | 279.1 | 527.0 | 198.5 | 159.3 | 316.4 |
| 1981 | 140.0 | 302.5 | 474.7 | 377.3 | 160.9 | 223.7 | 264.6 | 547.8 | 679.5 | 254.1 | 92.8 | 441.9 |
| 1982 | 146.8 | 236.8 | 404.2 | 551.6 | 458.8 | 1265.7 | 530.8 | 236.8 | 366.7 | 340.0 | 139.0 | 337.4 |
| 1983 | 182.3 | 308.6 | 416.7 | 452.8 | 245.8 | 595.4 | 265.2 | 190.4 | 395.5 | 267.6 | 118.4 | 404.9 |
| 1984 | 156.5 | 358.0 | 540.7 | 236.6 | 147.6 | 399.1 | 493.1 | 421.1 | 814.8 | 270.9 | 139.4 | 409.2 |
| 1985 | 135.9 | 275.3 | 354.8 | 613.5 | 536.1 | 134.3 | 211.2 | 339.0 | 474.5 | 296.3 | 407.4 | 297.5 |
| STATISTICS | | | | | | | | | | | | |
| N | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| AVERAGE | 149.9 | 283.8 | 418.4 | 486.1 | 374.5 | 483.7 | 301.2 | 288.0 | 480.4 | 276.6 | 174.1 | 333.9 |
| MAXIMUM | 218.4 | 358.0 | 676.6 | 976.1 | 840.8 | 1265.7 | 999.7 | 547.8 | 941.4 | 475.8 | 407.4 | 441.9 |
| MINIMUM | 93.9 | 129.9 | 233.9 | 236.6 | 68.4 | 66.1 | 60.3 | 111.7 | 108.9 | 198.5 | 92.8 | 152.3 |

# TABLE 8-2

CLEARWATER RIVER AT SPALDING (13342500)
REGULATED MONTHLY DISCHARGE VOLUME IN 1,000 ACRE-FEET
DRAINAGE AREA: 9,570 SQUARE MILES

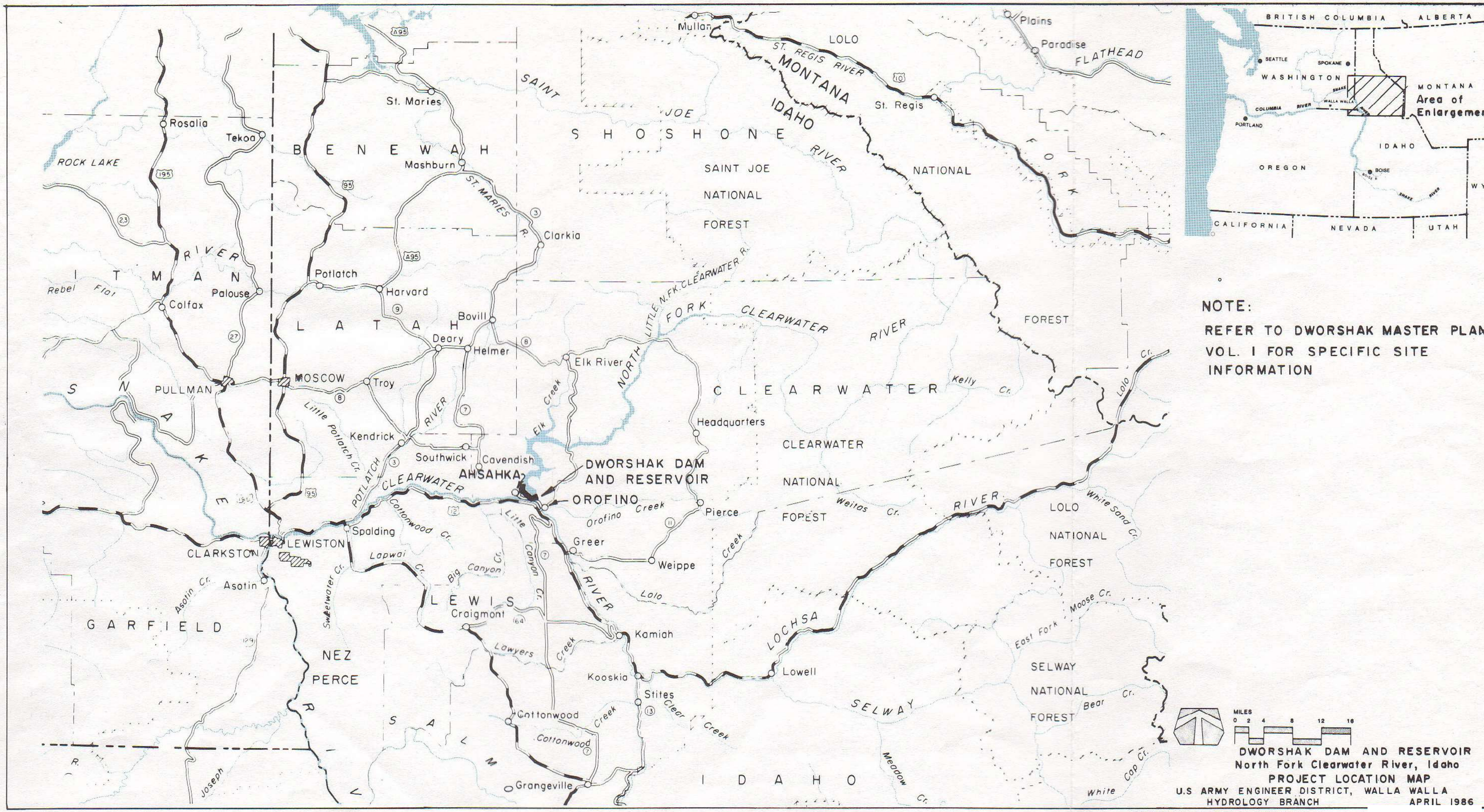
| Water Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1972 | 105.2 | 131.4 | 152.5 | 307.7 | 633.4 | 2139.8 | 1897.2 | 3884.9 | 3534.0 | 1140.9 | 311.0 | 198.5 |
| 1973 | 186.4 | 310.6 | 493.7 | 492.6 | 186.0 | 328.0 | 461.8 | 1241.9 | 868.2 | 424.0 | 245.1 | 446.8 |
| 1974 | 262.1 | 394.3 | 737.8 | 1679.6 | 1310.7 | 1838.3 | 2422.6 | 2415.9 | 4377.8 | 1166.4 | 317.8 | 393.1 |
| 1975 | 232.3 | 425.0 | 332.9 | 508.5 | 902.8 | 1158.4 | 880.4 | 2278.8 | 3509.6 | 1469.8 | 466.0 | 607.3 |
| 1976 | 507.9 | 714.9 | 1671.1 | 1279.0 | 1039.9 | 1301.2 | 1768.3 | 3033.4 | 2347.3 | 960.8 | 381.4 | 464.4 |
| 1977 | 283.3 | 416.8 | 426.3 | 483.5 | 359.9 | 300.0 | 691.8 | 1180.6 | 765.6 | 450.7 | 298.4 | 286.3 |
| 1978 | 317.8 | 557.3 | 1214.7 | 1099.5 | 1061.2 | 1493.6 | 1296.6 | 1880.4 | 2116.8 | 909.8 | 365.3 | 537.3 |
| 1979 | 203.1 | 421.3 | 734.8 | 614.2 | 363.5 | 939.5 | 1000.3 | 2666.4 | 1637.6 | 502.6 | 286.8 | 272.8 |
| 1980 | 258.1 | 375.9 | 622.9 | 549.5 | 415.5 | 541.0 | 1095.2 | 1950.8 | 1791.5 | 624.0 | 286.2 | 456.9 |
| 1981 | 244.3 | 504.7 | 926.1 | 821.3 | 668.8 | 639.6 | 1003.2 | 1979.3 | 2537.3 | 723.8 | 229.3 | 543.4 |
| 1982 | 277.4 | 386.4 | 657.6 | 818.9 | 1293.4 | 2089.6 | 1497.2 | 2341.1 | 2702.3 | 1188.9 | 331.2 | 467.7 |
| 1983 | 396.3 | 505.2 | 650.7 | 821.7 | 690.3 | 1333.7 | 904.5 | 1553.5 | 1522.9 | 751.6 | 292.9 | 524.8 |
| 1984 | 297.7 | 598.6 | 722.2 | 681.9 | 513.1 | 1290.5 | 1572.9 | 2345.7 | 3134.5 | 870.4 | 304.0 | 566.5 |
| 1985 | 278.9 | 475.0 | 518.5 | 751.9 | 657.9 | 470.7 | 1354.7 | 2163.8 | 1560.8 | 503.1 | 544.0 | 510.2 |

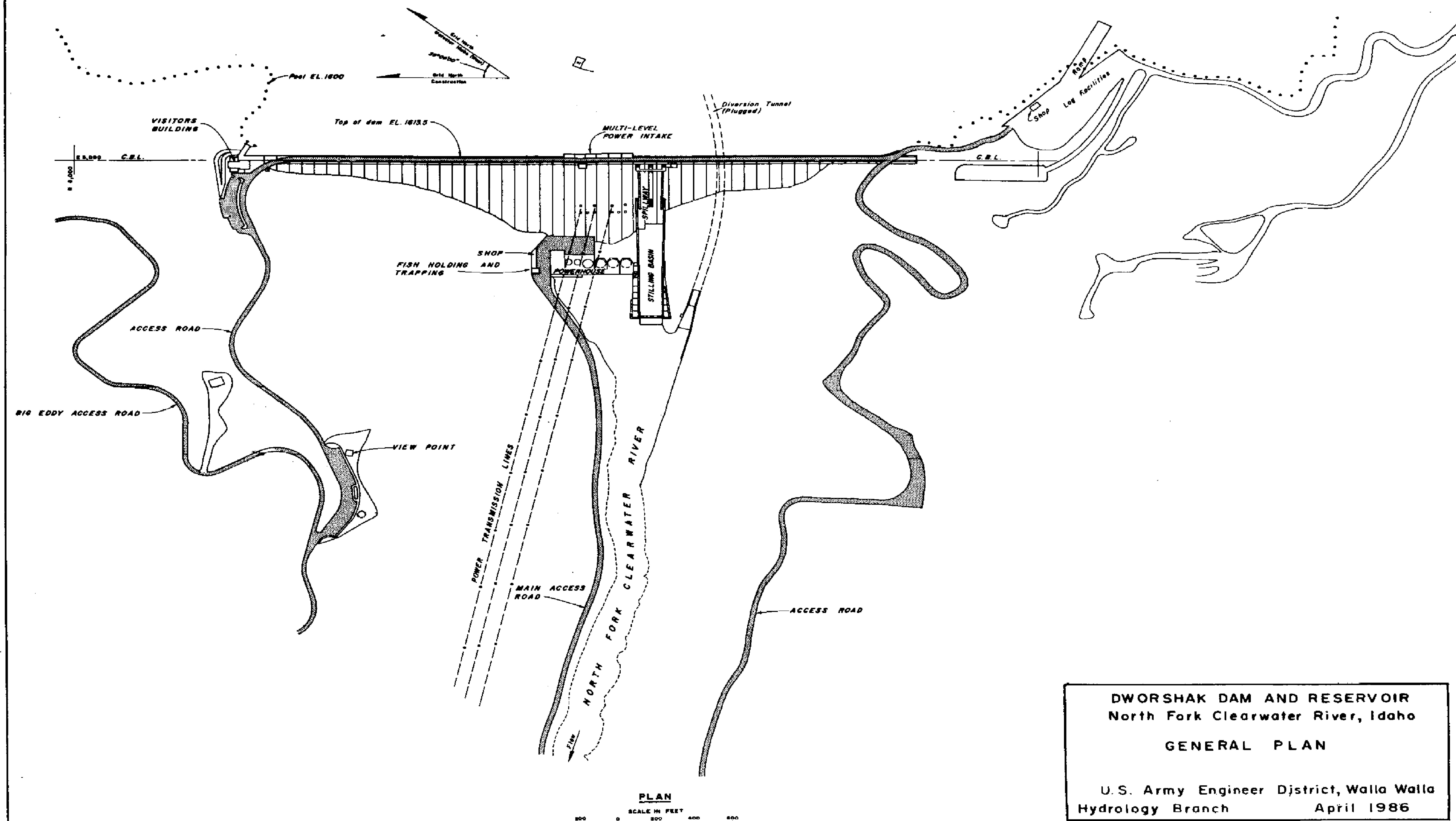
STATISTICS

| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| AVERAGE | 275.1 | 444.1 | 704.4 | 779.3 | 721.2 | 1133.1 | 1274.8 | 2208.3 | 2314.7 | 834.8 | 332.8 | 448.3 |
| MAXIMUM | 507.9 | 714.9 | 1671.1 | 1679.6 | 1310.7 | 2139.8 | 2422.6 | 3884.9 | 4377.8 | 1469.8 | 544.0 | 607.3 |
| MINIMUM | 105.2 | 131.4 | 152.5 | 307.7 | 186.0 | 300.0 | 461.8 | 1180.6 | 765.6 | 424.0 | 229.3 | 198.5 |

# PLATES

No 1.

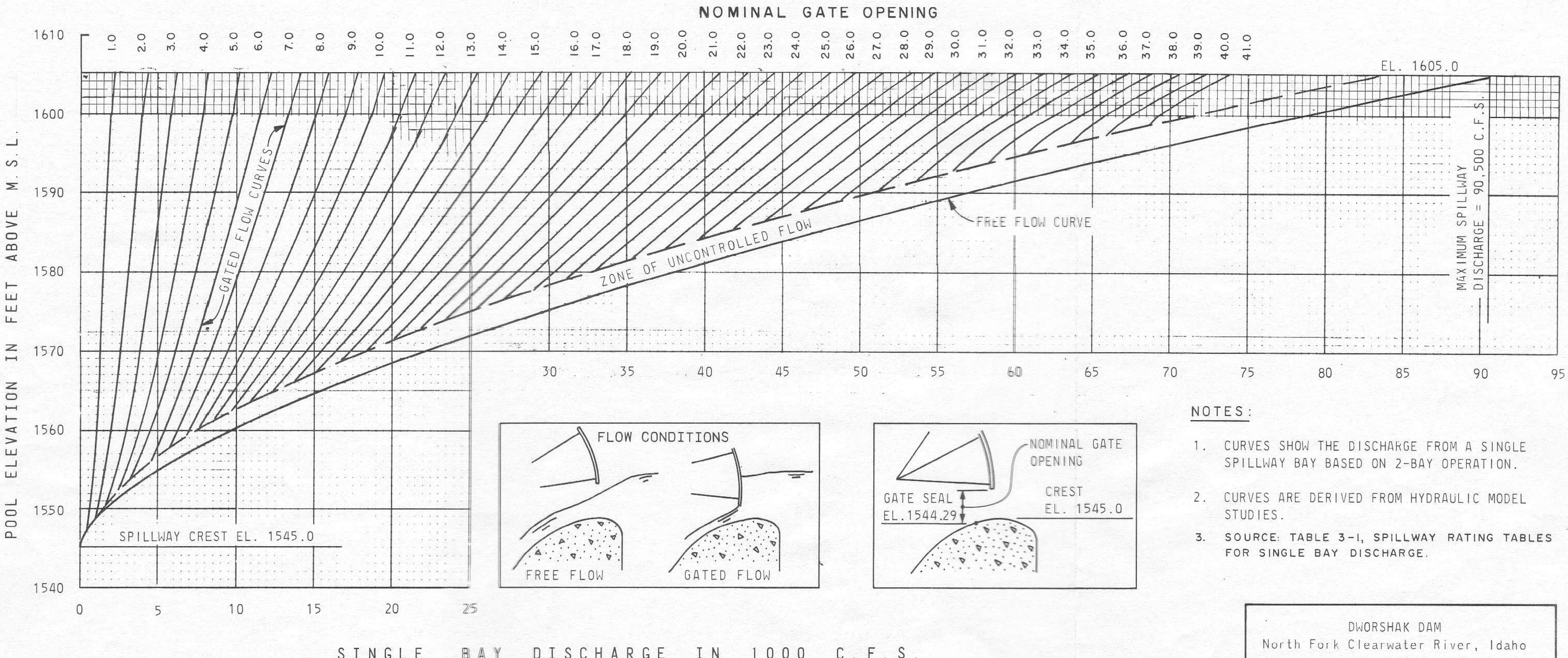

NOTE:
REFER TO DWORSHAK MASTER PLAN
VOL. I FOR SPECIFIC SITE
INFORMATION
BRITISH COLUMBIA
ALBERTA
WASHINGTON
MONTANA
Area of Enlargement
OREGON
IDAHO
WY
CALIFORNIA
NEVADA
UTAH
SEATTLE
SPOKANE
PORTLAND
BOISE
Mullan
Plains
Paradise
FLATHEAD
LOLO
ST. REGIS RIVER
MONTANA
IDAHO
St. Regis
SAINT
JOE
SHOSHONE
RIVER
NATIONAL
SAINT JOE
NATIONAL
FOREST
FORK
BENEWAH
St. Maries
Mashburn
ST. MARIES R.
Clarkia
Rosalia
Tekoa
ROCK LAKE
WHITMAN
RIVER
Rebel Flat
Colfax
Palouse
Potlatch
Harvard
LATAH
Bovill
Deary
Helmer
Elk River
PULLMAN
MOSCOW
Troy
SNAKE
Little Potlatch Cr.
Kendrick
RIVER
Southwick
Cavendish
POTLATCH
CLEARWATER
AHSAHKA
DWORSHAK DAM
AND RESERVOIR
OROFINO
Elk Creek
NORTH FORK CLEARWATER RIVER
LITTLE N. FK. CLEARWATER R.
FOREST
CLEARWATER
Kelly Cr.
Headquarters
CLEARWATER
NATIONAL
FOREST
Weitas Cr.
Pierce
Orofino Creek
Greer
Weippe
LEWISTON
CLARKSTON
Spalding
Cottonwood Cr.
Lapwai Cr.
Little Canyon Cr.
Big Canyon Cr.
RIVER
Lolo
Creek
RIVER
LOLO
NATIONAL
FOREST
White Sand Cr.
Lolo Cr.
Asotin
Asotin Cr.
Sweetwater Cr.
LEWIS
Craigmont
GARFIELD
NEZ
PERCE
Lawyers Creek
Kamiah
Kooskia
LOCHSA
Lowell
East Fork Moose Cr.
SELWAY
NATIONAL
FOREST
Bear Cr.
SELWAY
Stites
Clear Creek
Cottonwood
Cottonwood Creek
Grangeville
SALMON
R.
Joseph
IDAHO
Meadow Cr.
White Cap Cr.
MILES
0 2 4 8 12 16
DWORSHAK DAM AND RESERVOIR
North Fork Clearwater River, Idaho
PROJECT LOCATION MAP
U.S ARMY ENGINEER DISTRICT, WALLA WALLA
HYDROLOGY BRANCH
APRIL 1986




DWORSHAK DAM AND RESERVOIR
North Fork Clearwater River, Idaho

GENERAL PLAN

U.S. Army Engineer District, Walla Walla
Hydrology Branch April 1986




NOTES:

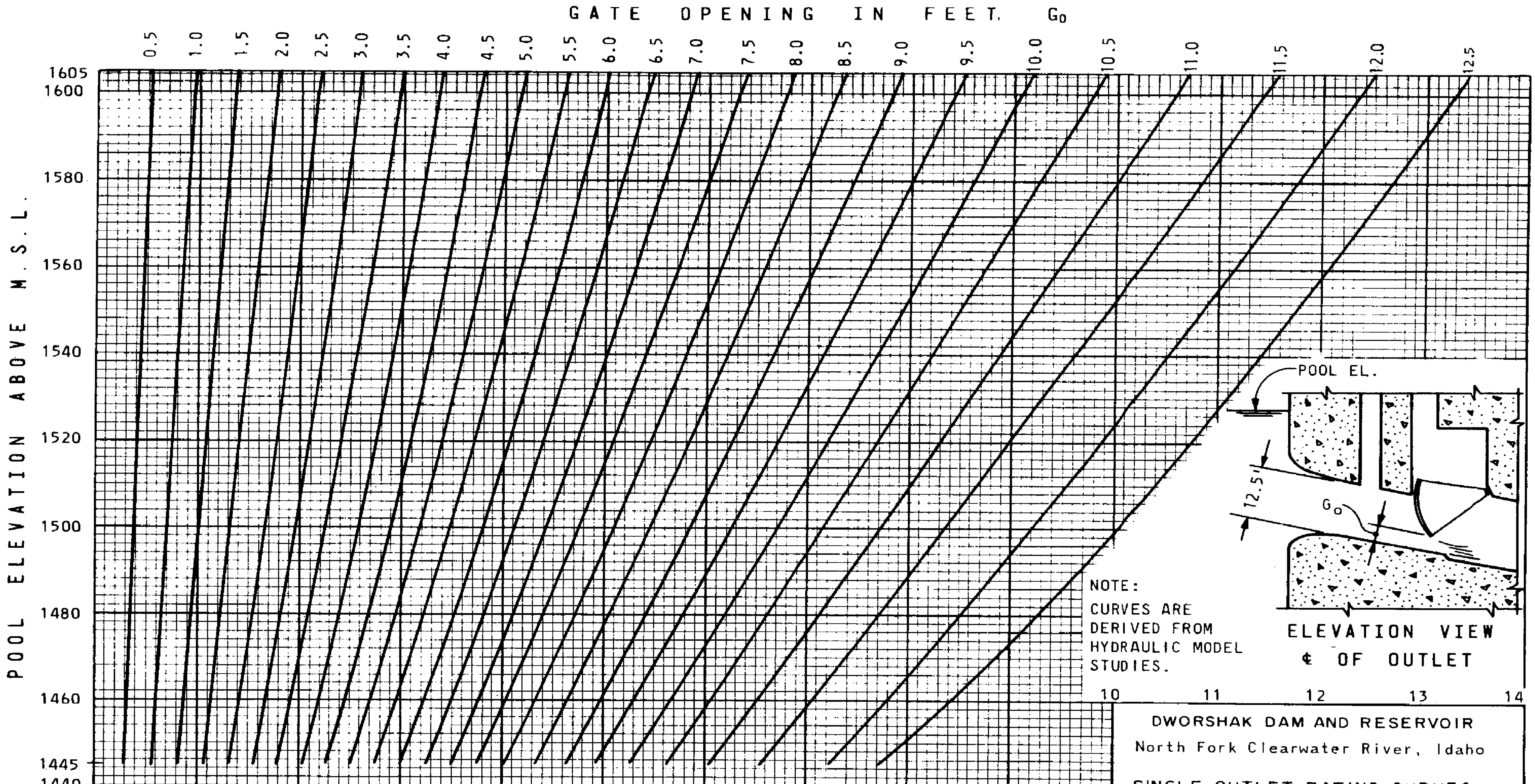
1. CURVES SHOW THE DISCHARGE FROM A SINGLE SPILLWAY BAY BASED ON 2-BAY OPERATION.
2. CURVES ARE DERIVED FROM HYDRAULIC MODEL STUDIES.
3. SOURCE: TABLE 3-I, SPILLWAY RATING TABLES FOR SINGLE BAY DISCHARGE.

DWORSHAK DAM
North Fork Clearwater River, Idaho

SPILLWAY RATING CURVES

SINGLE BAY

U. S. Army Engr. Dist., Walla Walla
Hydraulic Design Section
R.P. July 1970



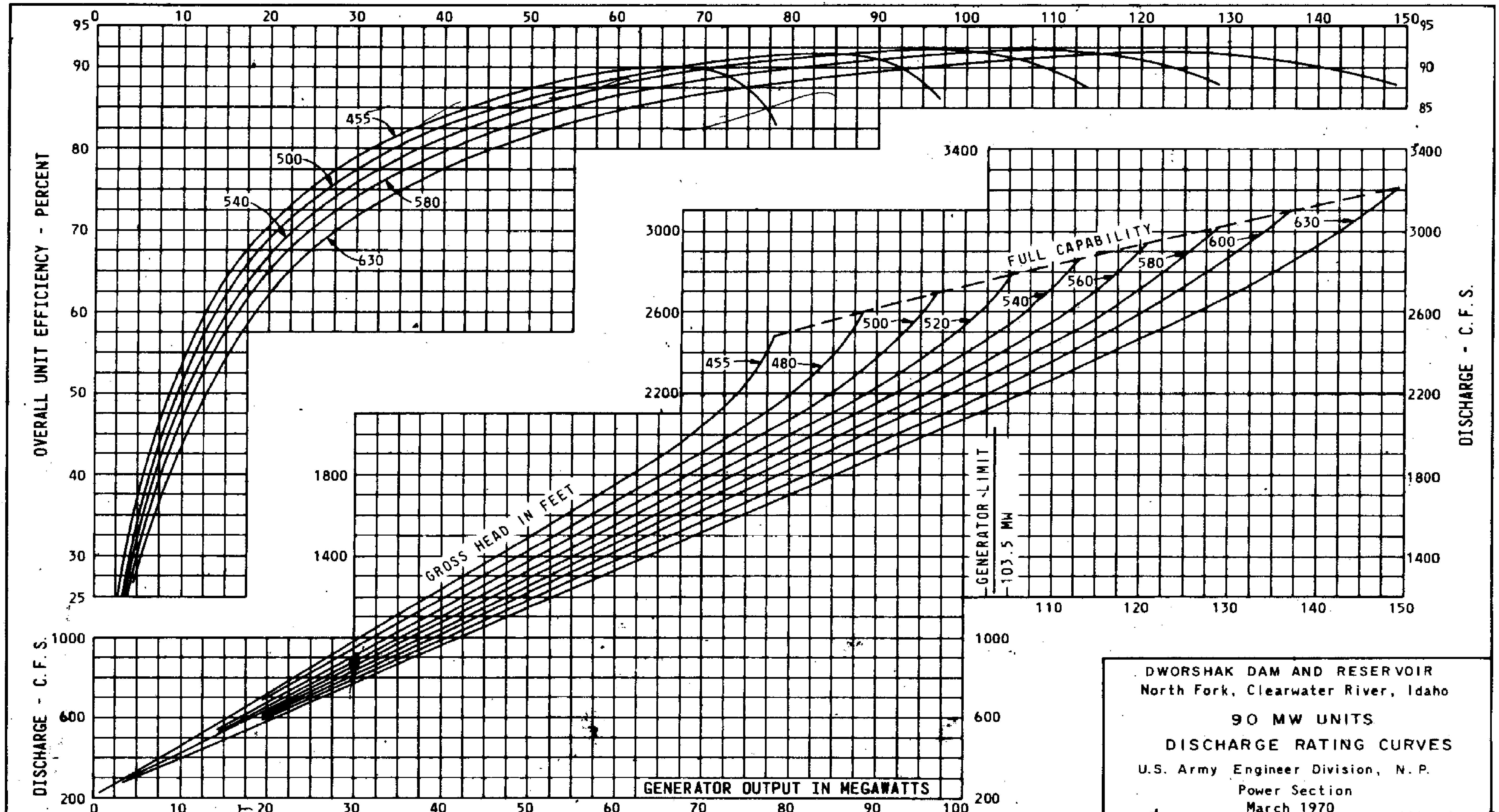

DWORSHAK DAM AND RESERVOIR

North Fork Clearwater River, Idaho

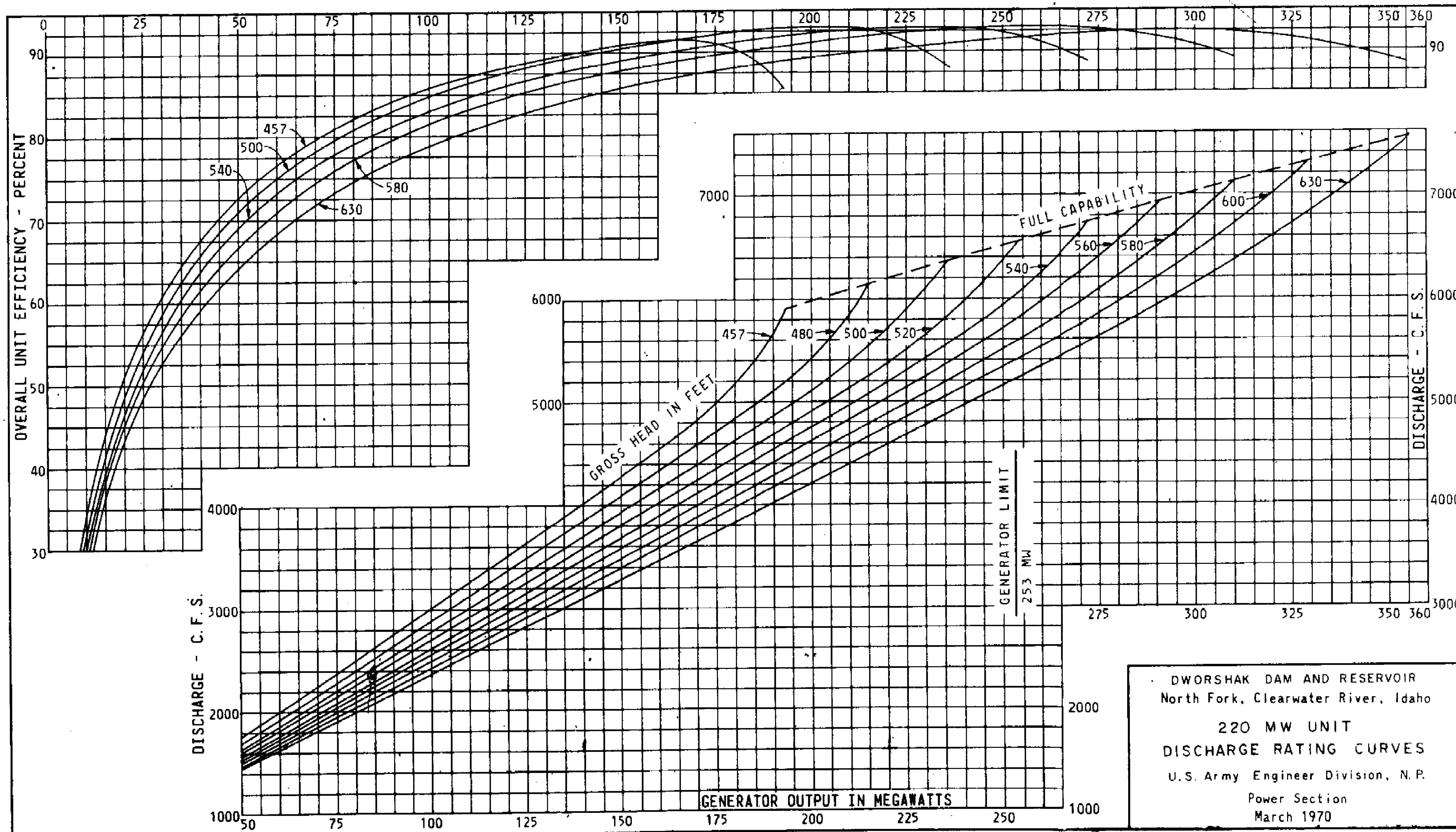
SINGLE OUTLET RATING CURVES

U.S. Army Engineer District, Walla Walla

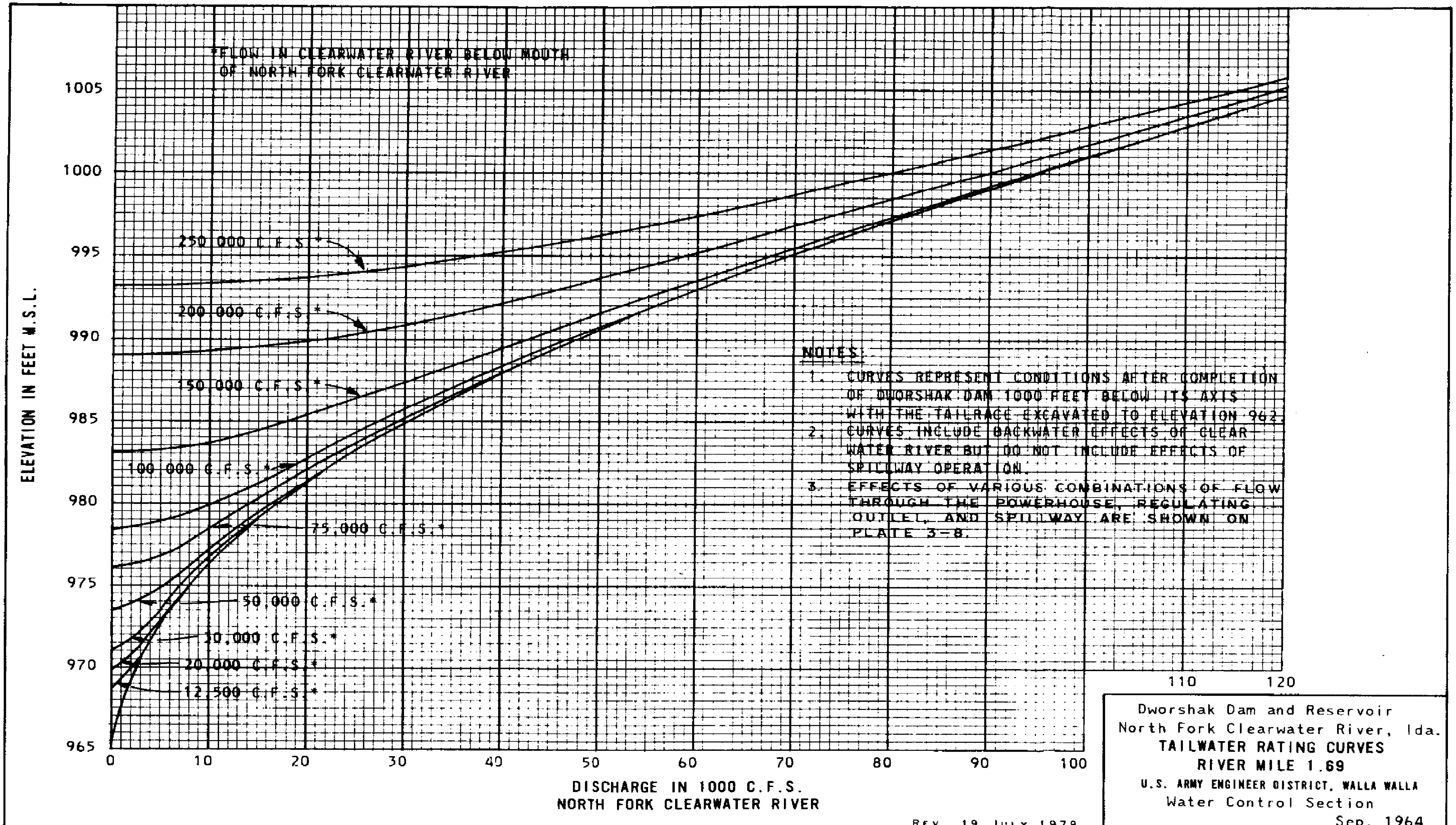
Hydraulic Design Section April 1986



OVERALL UNIT EFFICIENCY - PERCENT
DISCHARGE - C. F. S.
GROSS HEAD IN FEET
FULL CAPABILITY
GENERATOR LIMIT
103.5 MW
455
480
500
520
540
560
580
600
630
GENERATOR OUTPUT IN MEGAWATTS
DWORSHAK DAM AND RESERVOIR
North Fork, Clearwater River, Idaho
90 MW UNITS
DISCHARGE RATING CURVES
U.S. Army Engineer Division, N. P.
Power Section
March 1970



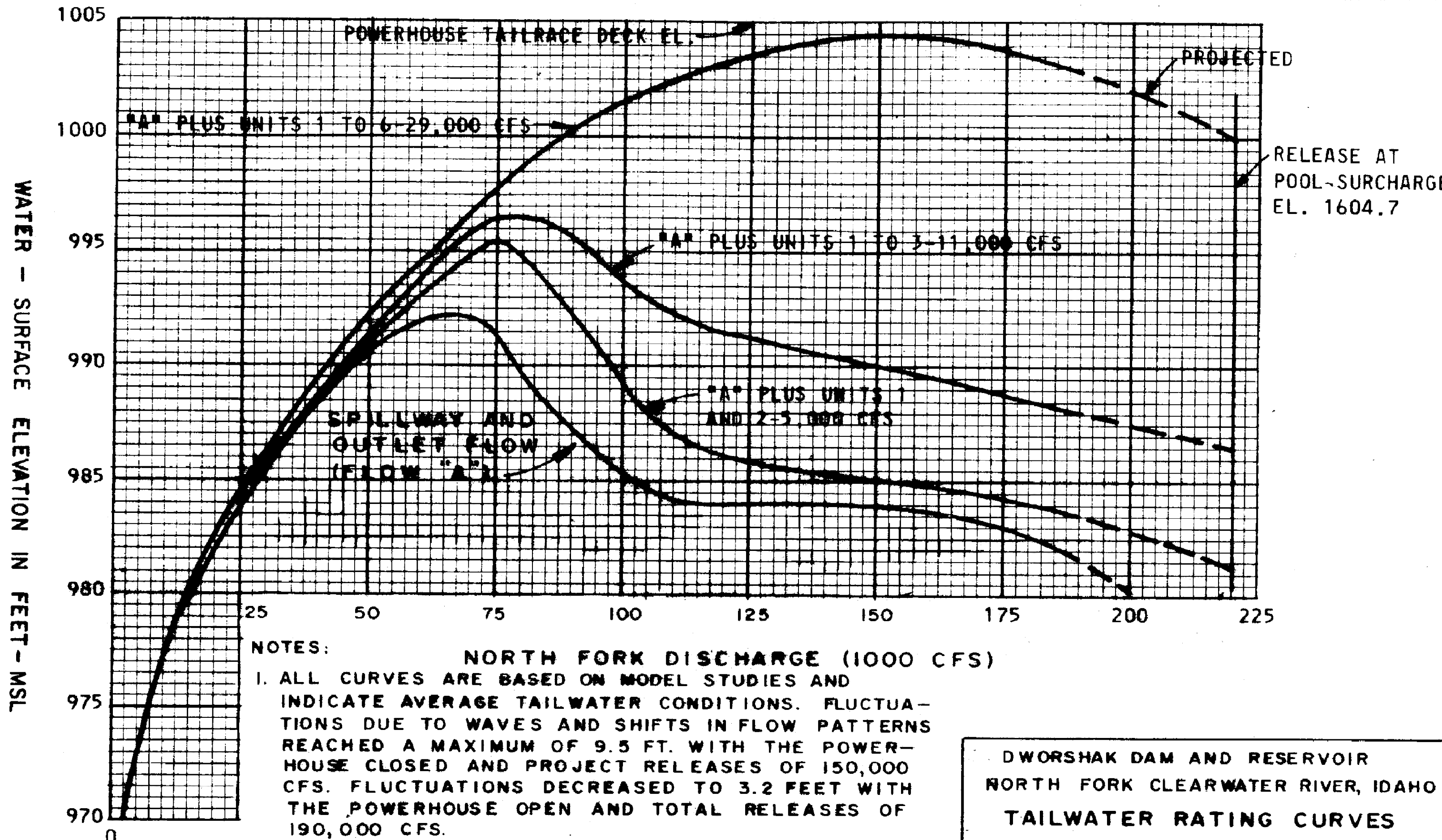
OVERALL UNIT EFFICIENCY - PERCENT
457
500
540
580
630
GROSS HEAD IN FEET
FULL CAPABILITY
480
520
560
600
DISCHARGE - C.F.S.
GENERATOR LIMIT 253 MW
GENERATOR OUTPUT IN MEGAWATTS
DWORSHAK DAM AND RESERVOIR
North Fork, Clearwater River, Idaho
220 MW UNIT
DISCHARGE RATING CURVES
U.S. Army Engineer Division, N.P.
Power Section
March 1970




Dworshak Dam and Reservoir
North Fork Clearwater River, Ida.

**TAILWATER RATING CURVES**
**RIVER MILE 1.69**

U.S. ARMY ENGINEER DISTRICT, WALLA WALLA
Water Control Section
Sep. 1964




NOTES:

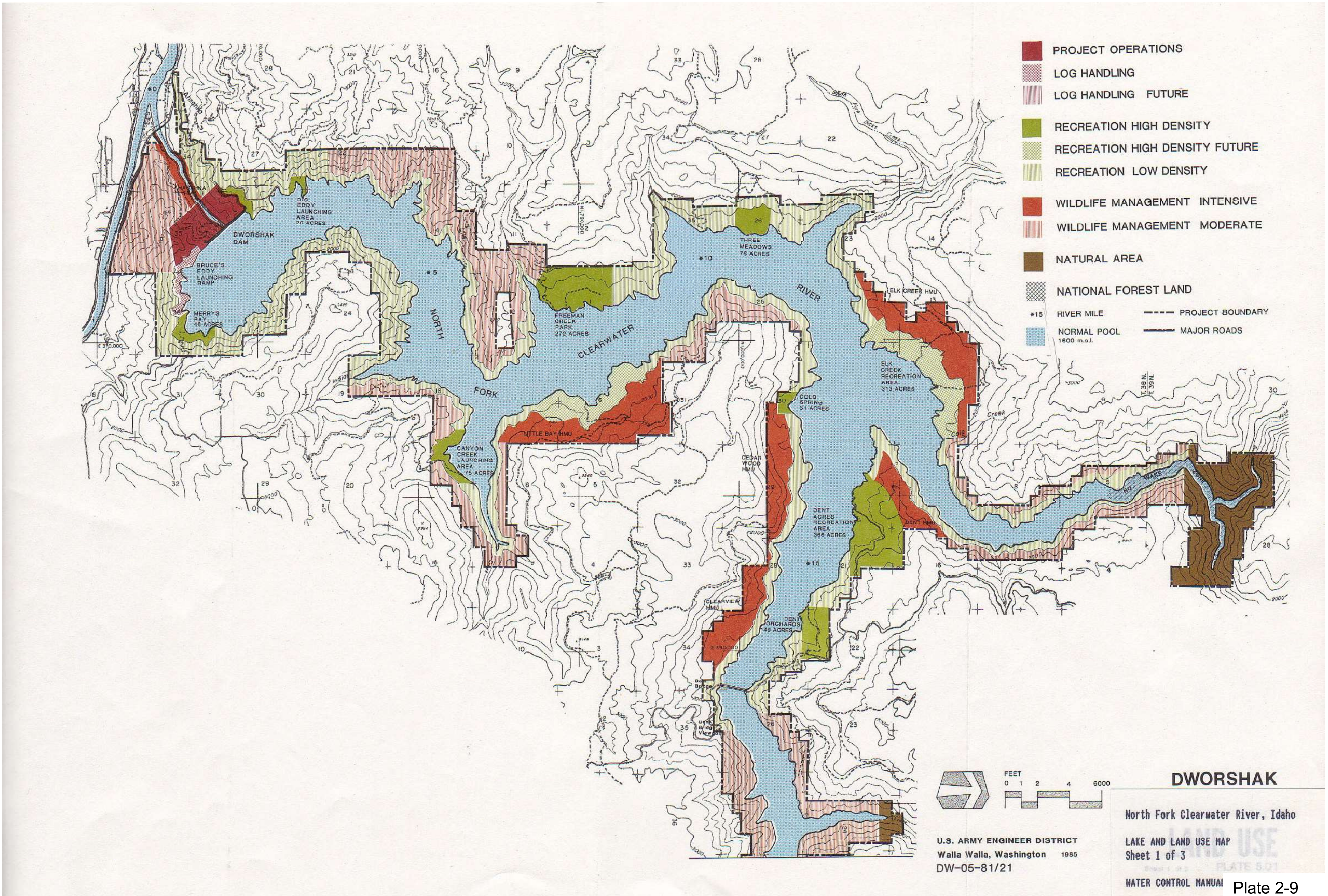
1. ALL CURVES ARE BASED ON MODEL STUDIES AND INDICATE AVERAGE TAILWATER CONDITIONS. FLUCTUATIONS DUE TO WAVES AND SHIFTS IN FLOW PATTERNS REACHED A MAXIMUM OF 9.5 FT. WITH THE POWERHOUSE CLOSED AND PROJECT RELEASES OF 150,000 CFS. FLUCTUATIONS DECREASED TO 3.2 FEET WITH THE POWERHOUSE OPEN AND TOTAL RELEASES OF 190,000 CFS.
2. TAILWATER ELEVATIONS AS SHOWN ASSUME AVERAGE CLEARWATER RIVER FLOWS FOR THE GIVEN NORTH FORK DISCHARGES.
3. AS PROJECT RELEASES INCREASE BEYOND ABOUT 75,000 CFS HIGH VELOCITY FLOWS FROM THE SPILLWAY PRODUCE A SWEPT STILLING BASIN CONDITION AND LOWER TAILWATER ELEVATIONS.

DWORSHAK DAM AND RESERVOIR
NORTH FORK CLEARWATER RIVER, IDAHO

TAILWATER RATING CURVES
AT POWERHOUSE UNITS 3 & 6

U.S. ARMY ENGINEER DIVISION,
N.P.

HYDRAULIC LAB.
SEPTEMBER 1984



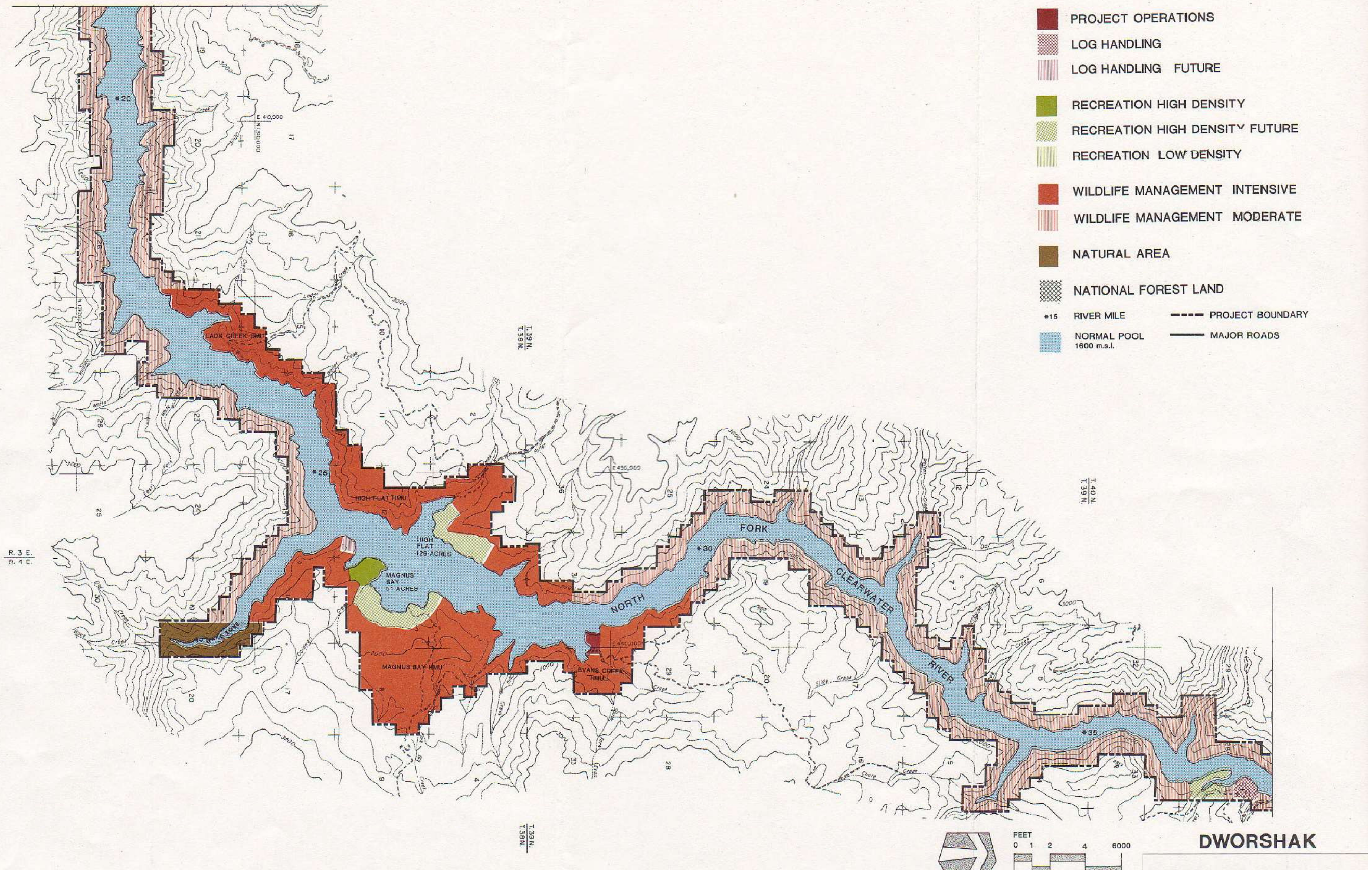

DWORSHAK

North Fork Clearwater River, Idaho

LAKE AND LAND USE MAP
Sheet 1 of 3

WATER CONTROL MANUAL

U.S. ARMY ENGINEER DISTRICT
Walla Walla, Washington 1985
DW-05-81/21




**DWORSHAK**

North Fork Clearwater River, Idaho

LAKE AND LAND USE MAP
Sheet 2 of 3

WATER CONTROL MANUAL

U.S. ARMY ENGINEER DISTRICT
Walla Walla, Washington 1985
DW-05-81/21

Plate 2-9

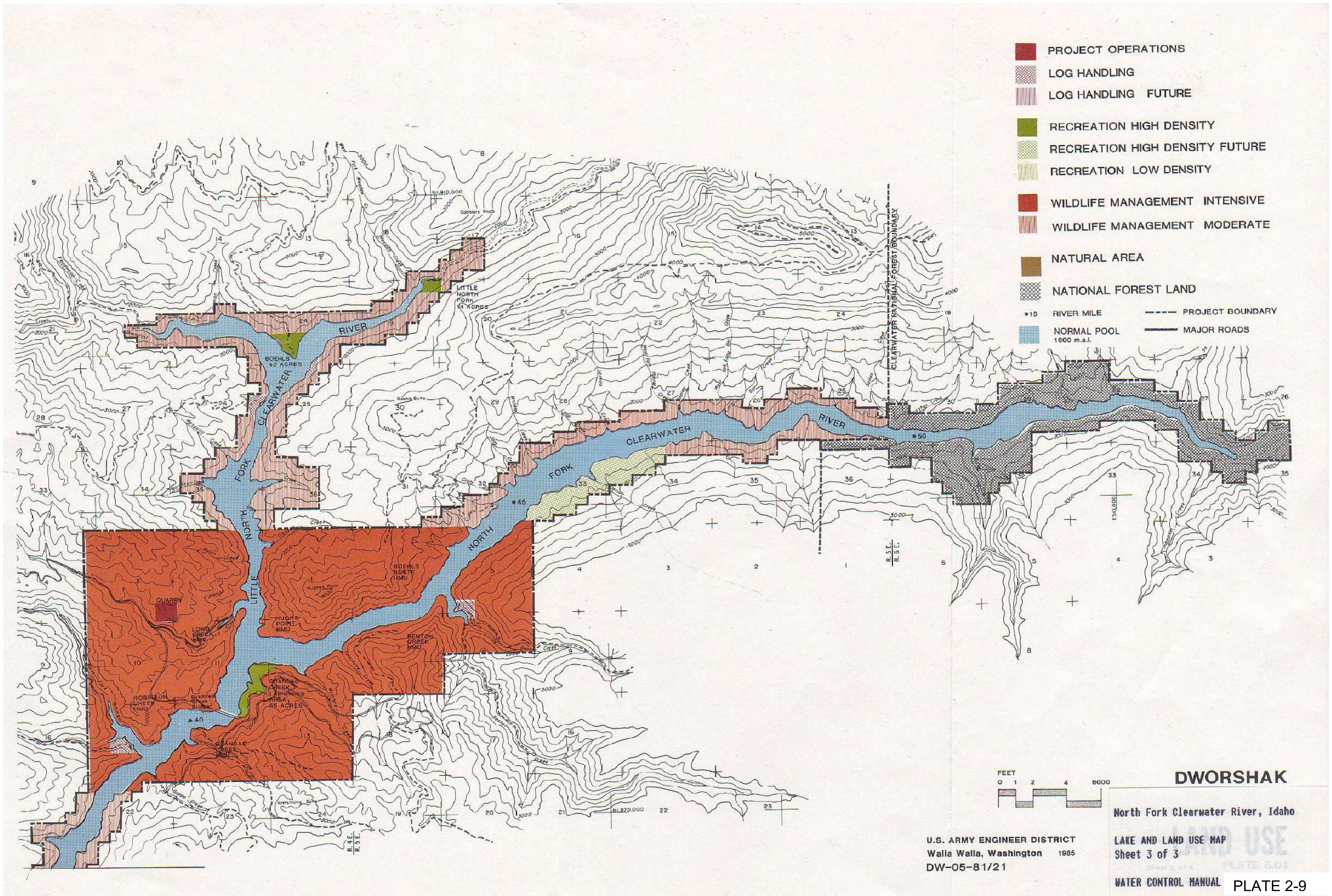
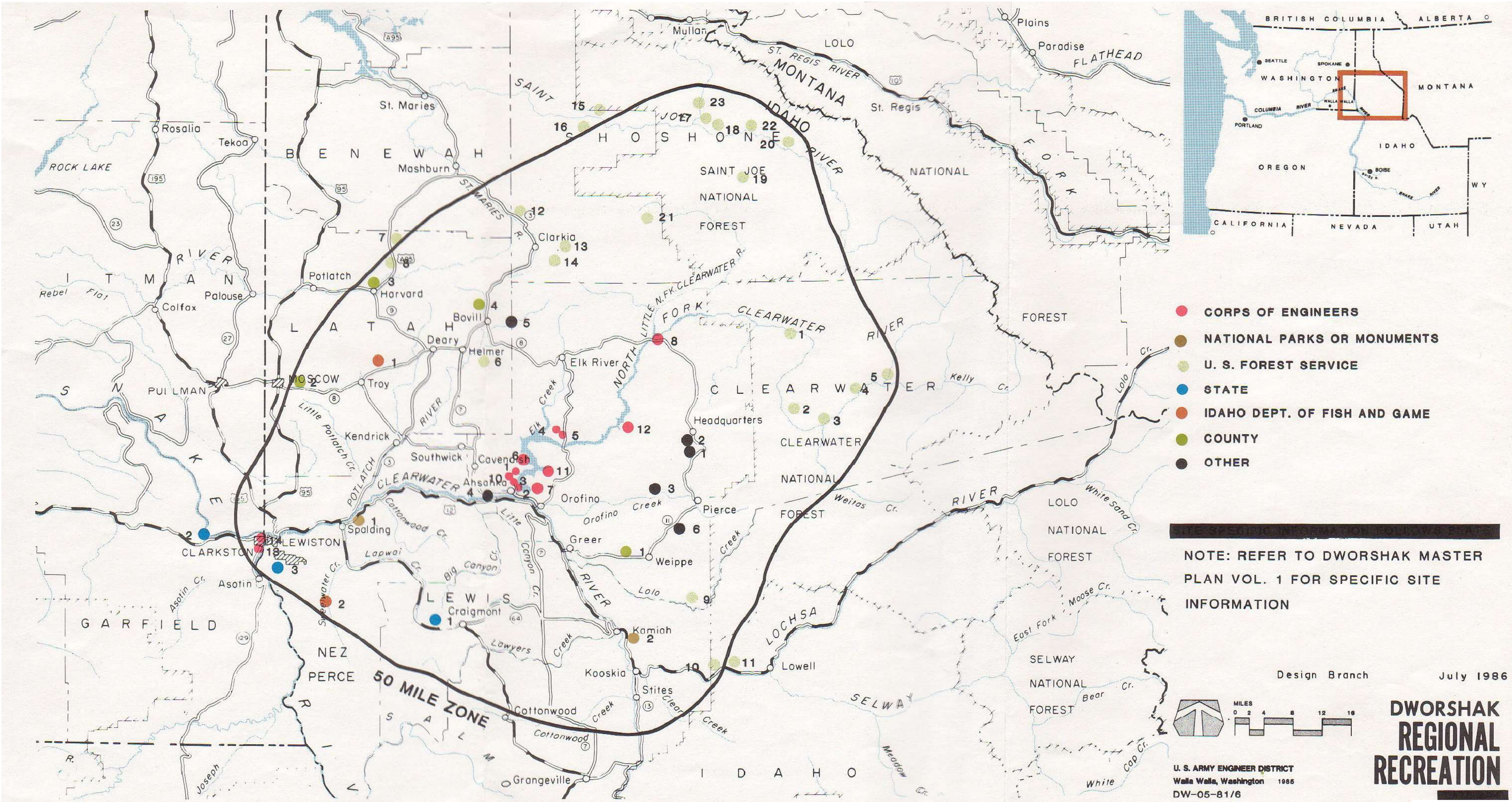
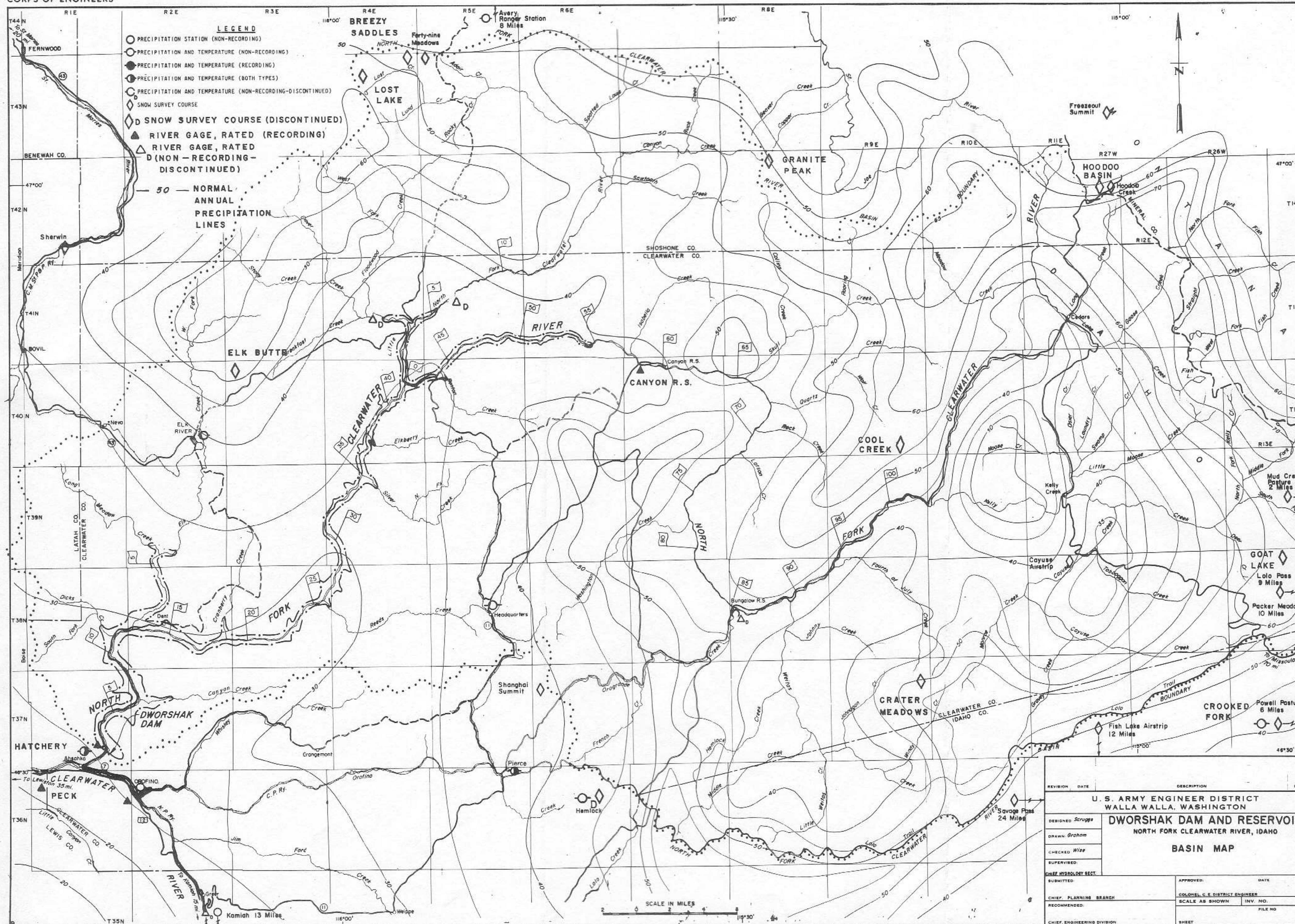

PROJECT OPERATIONS
LOG HANDLING
LOG HANDLING FUTURE
RECREATION HIGH DENSITY
RECREATION HIGH DENSITY FUTURE
RECREATION LOW DENSITY
WILDLIFE MANAGEMENT INTENSIVE
WILDLIFE MANAGEMENT MODERATE
NATURAL AREA
NATIONAL FOREST LAND
•15 RIVER MILE
PROJECT BOUNDARY
NORMAL POOL 1600 m.s.l.
MAJOR ROADS
CLEARWATER NATIONAL FOREST BOUNDARY
LITTLE NORTH FORK CLEARWATER RIVER
NORTH FORK CLEARWATER RIVER
BOEHLS 42 ACRES
LITTLE NORTH FORK 14 ACRES
QUARRY
LONG CREEK HMU
HUGHS POINT HMU
BOEHLS BUTTE HMU
BENTON CREEK HMU
ROBINSON CREEK HMU
GRANDAD CREEK HMU
GRANDAD CREEK CAMPING AREA 86 ACRES
FEET
0 1 2 4 6000
DWORSHAK
North Fork Clearwater River, Idaho
LAKE AND LAND USE MAP
Sheet 3 of 3
WATER CONTROL MANUAL
U.S. ARMY ENGINEER DISTRICT
Walla Walla, Washington 1985
DW-05-81/21

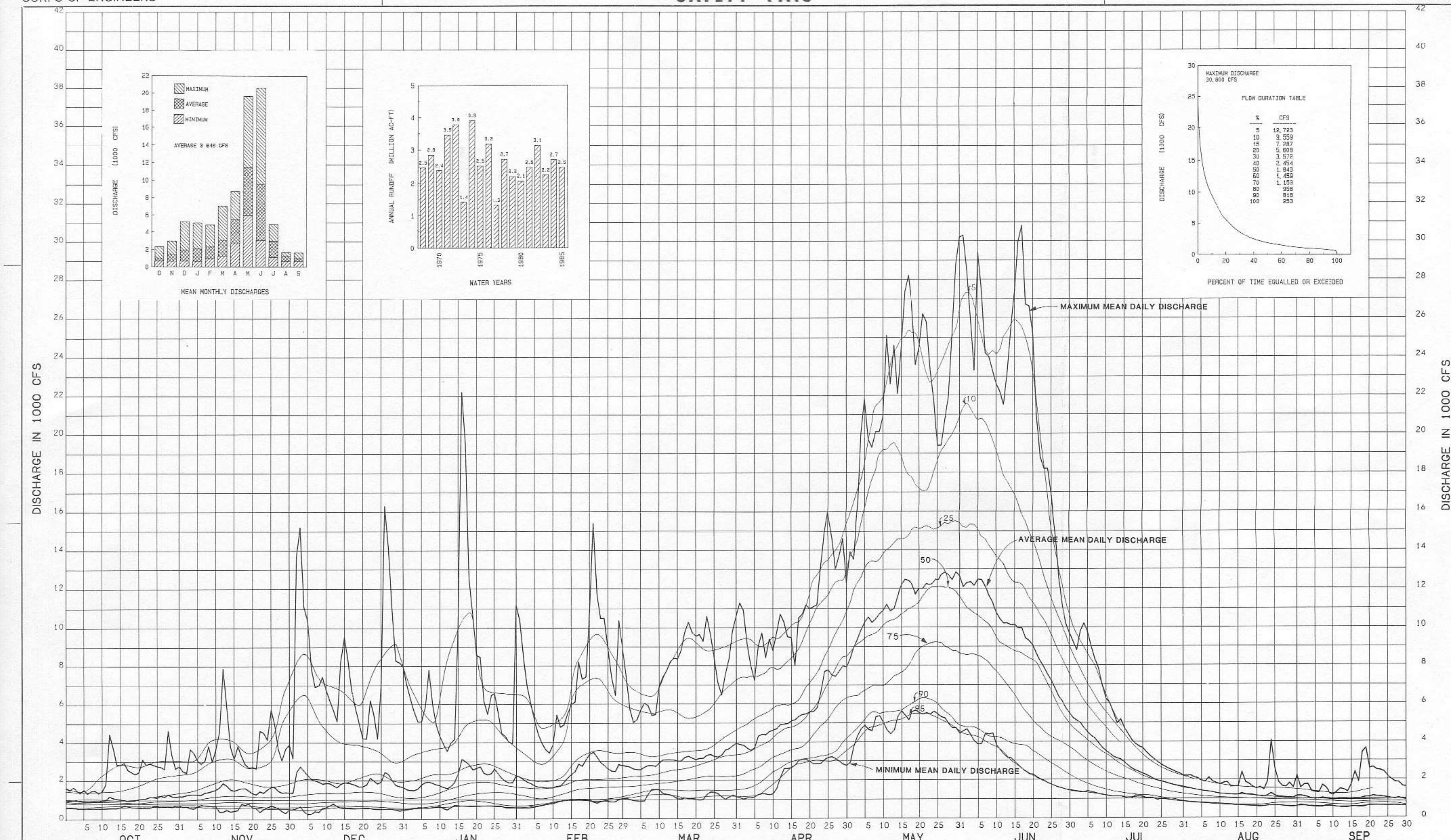
PLATE 2-9



CORPS OF ENGINEERS
NATIONAL PARKS OR MONUMENTS
U. S. FOREST SERVICE
STATE
IDAHO DEPT. OF FISH AND GAME
COUNTY
OTHER
[redacted]
NOTE: REFER TO DWORSHAK MASTER PLAN VOL. 1 FOR SPECIFIC SITE INFORMATION
Design Branch
July 1986
MILES
0 2 4 8 12 16
U. S. ARMY ENGINEER DISTRICT
Walla Walla, Washington 1985
DW-05-81/6
DWORSHAK
REGIONAL
RECREATION
50 MILE ZONE
BRITISH COLUMBIA
ALBERTA
WASHINGTON
MONTANA
IDAHO
OREGON
CALIFORNIA
NEVADA
UTAH
WY
SEATTLE
SPOKANE
PORTLAND
BOISE
COLUMBIA RIVER
WALLA WALLA
SNAKE RIVER
Rosalia
Tekoa
ROCK LAKE
Colfax
Palouse
PULLMAN
MOSCOW
Troy
Kendrick
Southwick
Potlatch
Harvard
Bovill
Deary
Helmer
Elk River
St. Maries
Mashburn
Clarkia
BENEWAH
LATAH
WHITMAN
SNAKE
CLARKSTON
LEWISTON
Asotin
Spalding
Lapwai
Craigmont
Cavendish
Ahsahka
Orofino
Greer
Weippe
Pierce
Headquarters
Kamiah
Kooskia
Stites
Lowell
Cottonwood
Grangeville
GARFIELD
NEZ PERCE
LEWIS
IDAHO
SHOSHONE
CLEARWATER
SAINT JOE NATIONAL FOREST
CLEARWATER NATIONAL FOREST
LOLO NATIONAL FOREST
SELWAY NATIONAL FOREST
Mullan
Plains
Paradise
St. Regis
MONTANA
IDAHO
LOLO
NATIONAL
FOREST
CLEARWATER RIVER
NORTH FORK CLEARWATER
LITTLE N. FK. CLEARWATER R.
LOCHSA
SELWAY
ST. REGIS RIVER
FLATHEAD
ST. MARIES R.
POTLATCH RIVER
SALMON RIVER


LEGEND
PRECIPITATION STATION (NON-RECORDING)
PRECIPITATION AND TEMPERATURE (NON-RECORDING)
PRECIPITATION AND TEMPERATURE (RECORDING)
PRECIPITATION AND TEMPERATURE (BOTH TYPES)
PRECIPITATION AND TEMPERATURE (NON-RECORDING-DISCONTINUED)
SNOW SURVEY COURSE
D SNOW SURVEY COURSE (DISCONTINUED)
RIVER GAGE, RATED (RECORDING)
RIVER GAGE, RATED
D (NON-RECORDING-DISCONTINUED)
50 — NORMAL ANNUAL PRECIPITATION LINES
BREEZY SADDLES
Forty-nine Meadows
LOST LAKE
Avery Ranger Station 8 Miles
GRANITE PEAK
HOODOO BASIN
Hoodoo Creek
Freezeout Summit
ELK BUTTE
CANYON R.S.
COOL CREEK
Kelly Creek
Cayuse Airstrip
GOAT LAKE
Lolo Pass 9 Miles
Packer Meadow 10 Miles
Mud Creek Pasture 2 Miles
CRATER MEADOWS
CROOKED FORK
Powell Pasture 6 Miles
Fish Lake Airstrip 12 Miles
Savage Pass 24 Miles
Shanghai Summit
Headquarters
Bungalow R.S.
Pierce
Hemlock
Grangemont
Weippe
Kamiah 13 Miles
HATCHERY
Ahsahka
OROFINO
PECK
To Lewiston 35 mi.
DWORSHAK DAM
NORTH FORK CLEARWATER RIVER
Elk River
Nevo
Bovil
Sherwin
Fernwood
Dent
SHOSHONE CO.
CLEARWATER CO.
IDAHO CO.
LATAH CO.
LEWIS CO.
BENEWAH CO.
MONTANA
SCALE IN MILES
U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON
DWORSHAK DAM AND RESERVOIR
NORTH FORK CLEARWATER RIVER, IDAHO
BASIN MAP
DESIGNED Scruggs
DRAWN Graham
CHECKED Wise
CHIEF, HYDROLOGY SECT.
CHIEF, PLANNING BRANCH
CHIEF, ENGINEERING DIVISION
COLONEL, C. E. DISTRICT ENGINEER
SCALE AS SHOWN

CORPS OF ENGINEERS SAFETY PAYS U. S. ARMY




NOTES

1. RECORDS USED:

   Water years 1968-1985, observed discharges for North Fork Clearwater River near Canyon Ranger Station, Idaho. Discharge records used are from data published by U.S.G.S.

2. Drainage area is 1,360 square miles.

3. Curves of percent chance of occurrence represent the average flow for that day. A point on an exceedence curve represents the average daily discharge for a specific day which has been exceeded the given percentage of time.

MAXIMUM ANNUAL MEAN DAILY DISCHARGES

| Water Year | Date | CFS |
|---|---|---|
| 1968 | Jun 3 | 12,600 |
| 1969 | May 13 | 16,800 |
| 1970 | Jun 6 | 18,800 |
| 1971 | May 13 | 24,600 |
| 1972 | Jun 1 | 30,300 |
| 1973 | May 18 | 9,610 |
| 1974 | Jun 17 | 30,800 |
| 1975 | Jun 3 | 20,600 |
| 1976 | May 11 | 25,100 |
| 1977 | May 2 | 9,570 |
| 1978 | Dec 3 | 15,200 |
| 1979 | May 6 | 19,700 |
| 1980 | Apr 29 | 14,600 |
| 1981 | Dec 26 | 16,300 |
| 1982 | May 26 | 19,400 |
| 1983 | May 30 | 15,300 |
| 1984 | May 31 | 20,300 |
| 1985 | May 24 | 18,300 |

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

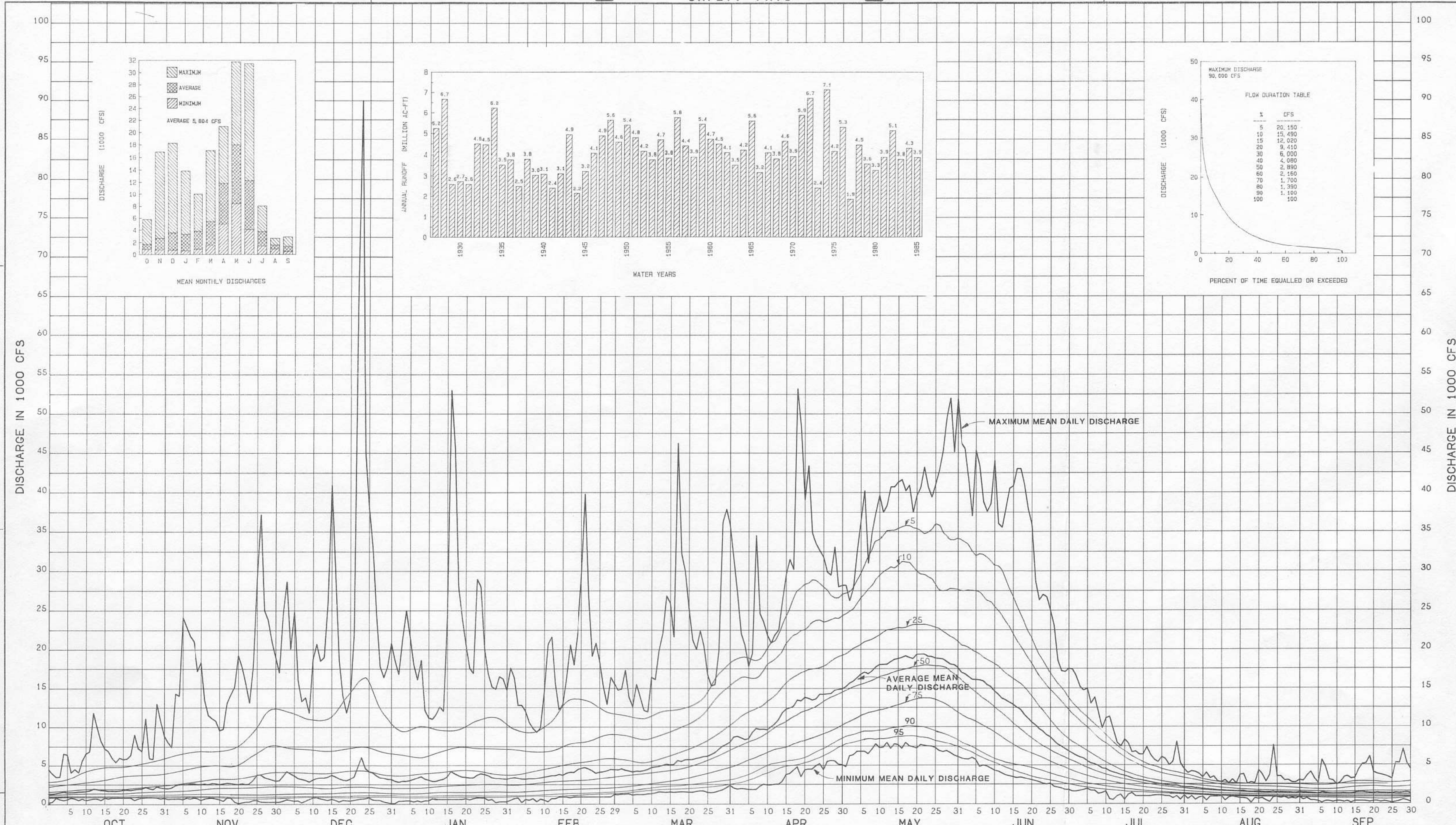
U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

DESIGNED:
DRAWN: Gerber Plotter
CHECKED:
SUPERVISED:
CHIEF, HYDROLOGY BRANCH

DWORSHAK DAM AND RESERVOIR
NORTH FORK CLEARWATER RIVER, IDAHO
SUMMARY HYDROGRAPHS
NORTH FORK CLEARWATER RIVER
NEAR CANYON RANGER STATION, IDAHO

SUBMITTED:
CHIEF, PLANNING DIVISION
DATE
SCALE AS SHOWN | INV. NO.
FILE NO.
SHEET

VALUE ENGINEERING PAYS




NOTES

1. RECORDS USED:

   a. Water years 1927-1971, observed discharges for the North Fork Clearwater River near Ahsahka, Idaho. (Data published by U.S.G.S.).

   b. Water years 1972-1985, Dworshak Reservoir inflow computed by Corps of Engineers, Walla Walla District.

2. Drainage area is 2,440 square miles.

3. Curves of percent chance of occurrence represent the average flow for that day. A point on an exceedence curve represents the average daily discharge for a specific day which has been exceeded the given percentage of time.

MAXIMUM ANNUAL MEAN DAILY INFLOWS

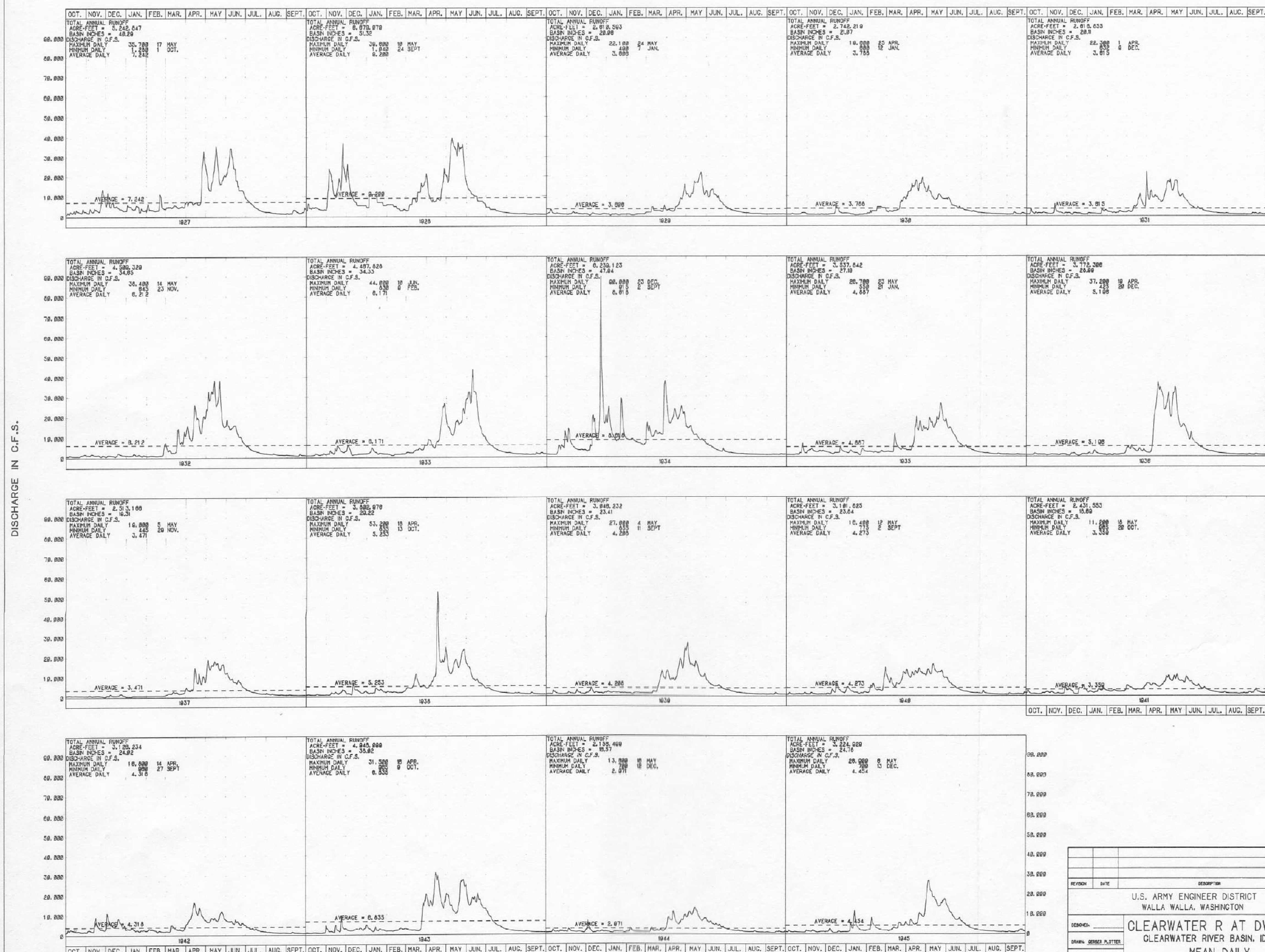
| Water Year | Date | CFS | Water Year | Date | CFS | Water Year | Date | CFS |
|---|---|---|---|---|---|---|---|---|
| 1927 | May 17 | 35,700 | 1947 | Dec 15 | 40,900 | 1967 | May 23 | 27,300 |
| 1928 | May 10 | 39,600 | 1948 | May 29 | 52,000 | 1968 | Feb 20 | 29,200 |
| 1929 | May 24 | 22,100 | 1949 | May 15 | 41,300 | 1969 | Apr 24 | 25,400 |
| 1930 | Apr 25 | 19,600 | 1950 | May 15 | 32,100 | 1970 | Jun 7 | 27,700 |
| 1931 | Apr 1 | 22,300 | 1951 | May 12 | 23,400 | 1971 | May 30 | 43,000 |
| 1932 | May 14 | 38,400 | 1952 | Apr 28 | 30,700 | 1972 | May 31 | 51,900 |
| 1933 | Jun 10 | 44,000 | 1953 | Apr 28 | 22,500 | 1973 | May 6 | 14,500 |
| 1934 | Dec 23 | 90,000 | 1954 | May 20 | 35,700 | 1974 | Jan 16 | 53,000 |
| 1935 | May 23 | 26,700 | 1955 | May 21 | 30,100 | 1975 | Jun 3 | 31,200 |
| 1936 | Apr 19 | 37,200 | 1956 | May 21 | 40,600 | 1976 | May 9 | 36,400 |
| 1937 | May 5 | 19,000 | 1957 | May 20 | 36,000 | 1977 | May 2 | 14,900 |
| 1938 | Apr 18 | 53,200 | 1958 | May 24 | 30,500 | 1978 | Dec 3 | 28,700 |
| 1939 | May 4 | 27,000 | 1959 | May 16 | 25,500 | 1979 | May 6 | 40,200 |
| 1940 | May 12 | 16,400 | 1960 | May 13 | 25,400 | 1980 | Apr 29 | 22,300 |
| 1941 | May 18 | 11,200 | 1961 | May 27 | 29,900 | 1981 | Dec 26 | 33,000 |
| 1942 | Apr 14 | 16,800 | 1962 | Apr 7 | 34,500 | 1982 | Feb 21 | 39,800 |
| 1943 | Apr 16 | 31,500 | 1963 | May 24 | 15,000 | 1983 | May 30 | 24,800 |
| 1944 | May 16 | 13,600 | 1964 | May 21 | 36,400 | 1984 | May 31 | 30,000 |
| 1945 | May 6 | 26,900 | 1965 | Dec 23 | 54,000 | 1985 | Jun 7 | 29,300 |
| 1946 | May 6 | 24,300 | 1966 | May 7 | 22,800 | | | |

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

**DWORSHAK DAM AND RESERVOIR**
NORTH FORK CLEARWATER RIVER, IDAHO
**SUMMARY HYDROGRAPHS**
DWORSHAK RESERVOIR NEAR AHSAHKA, IDAHO
UNREGULATED DISCHARGE

Designed by: Gerber Plotter

SCALE AS SHOWN




| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

# CLEARWATER R AT DWORSHAK

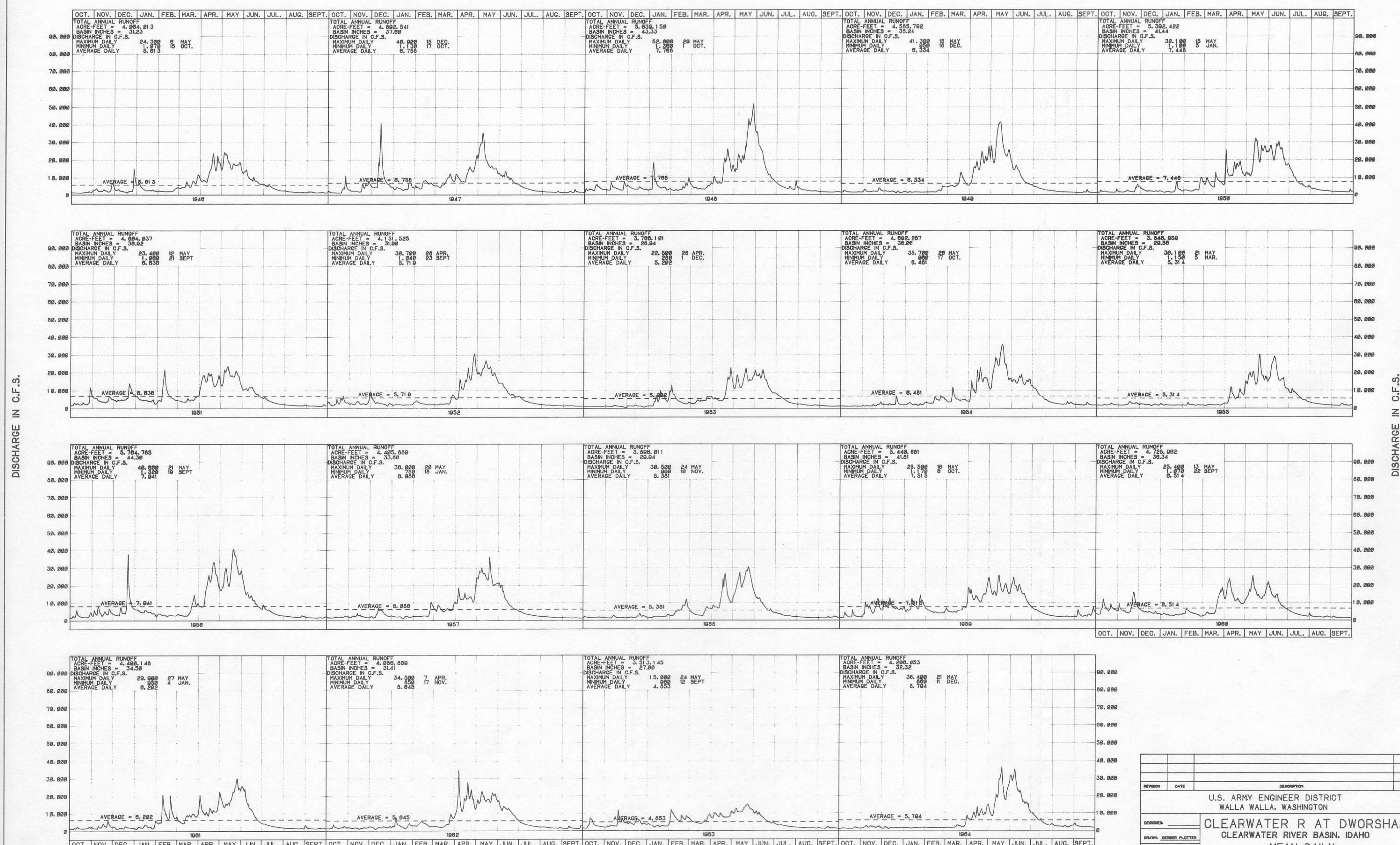
CLEARWATER RIVER BASIN, IDAHO

MEAN DAILY

TOTAL UNREGULATED INFLOW

PERIOD OF RECORD: 9/1926 - 10/1985

DESIGNED:
DRAWN: GERBER PLOTTER
CHECKED:
PREPARED:
SUPERVISED:
CHIEF, HYDROLOGY BRANCH
SUBMITTED:
CHIEF, PLANNING DIVISION
APPROVED: DATE
SCALE AS SHOWN INV. NO. ENC.
FILE NO.
SHEET 1 OF 4



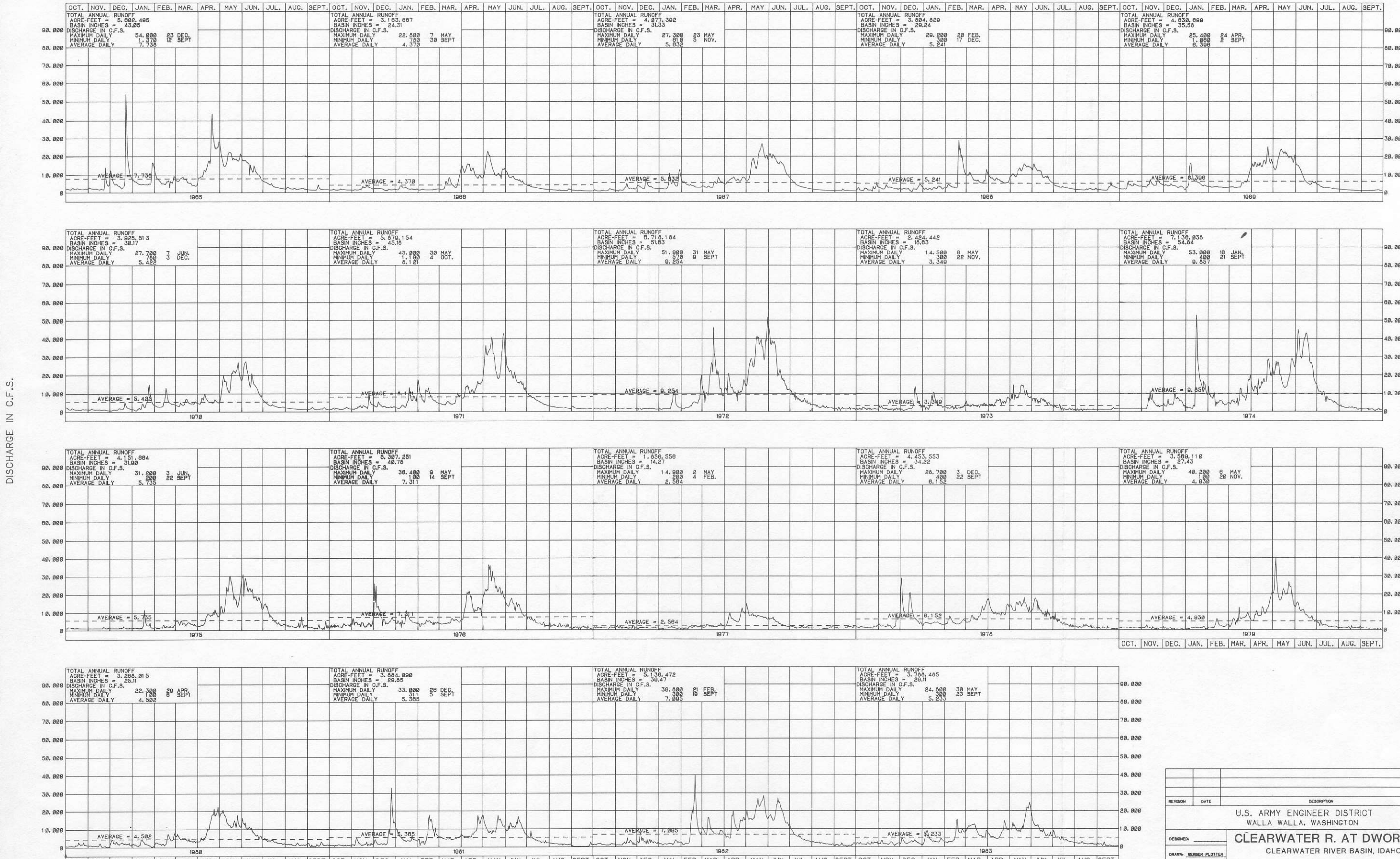

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

CLEARWATER R AT DWORSHAK
CLEARWATER RIVER BASIN, IDAHO
MEAN DAILY
TOTAL UNREGULATED INFLOW
PERIOD OF RECORD: 10/1926 - 9/1985

DRAWN: GERBER PLOTTER

SCALE AS SHOWN

SHEET 2 OF 4




| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

DESIGNED:
DRAWN: GERBER PLOTTER
CHECKED:
PREPARED:

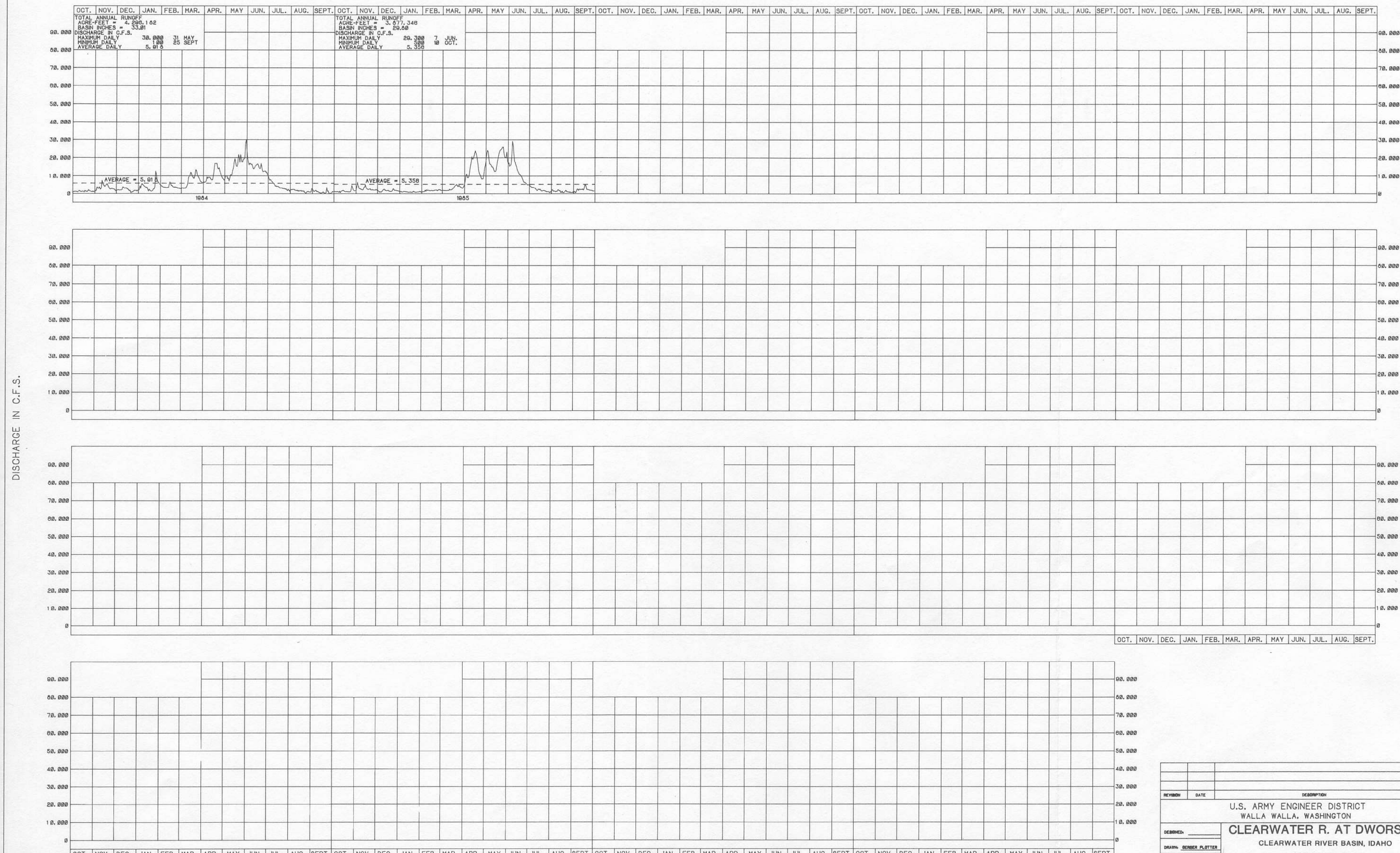
## CLEARWATER R. AT DWORSHAK

CLEARWATER RIVER BASIN, IDAHO

### MEAN DAILY
### TOTAL UNREGULATED INFLOW

PERIOD OF RECORD: 9/1926 - 10/1985

SUPERVISED: | APPROVED: | DATE
CHIEF, HYDROLOGY BRANCH
SUBMITTED: | SCALE AS SHOWN | INV. NO. ENG.
FILE NO.
CHIEF, PLANNING DIVISION | SHEET 3 OF 4




| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

DESIGNED:
DRAWN: GERBER PLOTTER
CHECKED:
PREPARED:

# CLEARWATER R. AT DWORSHAK

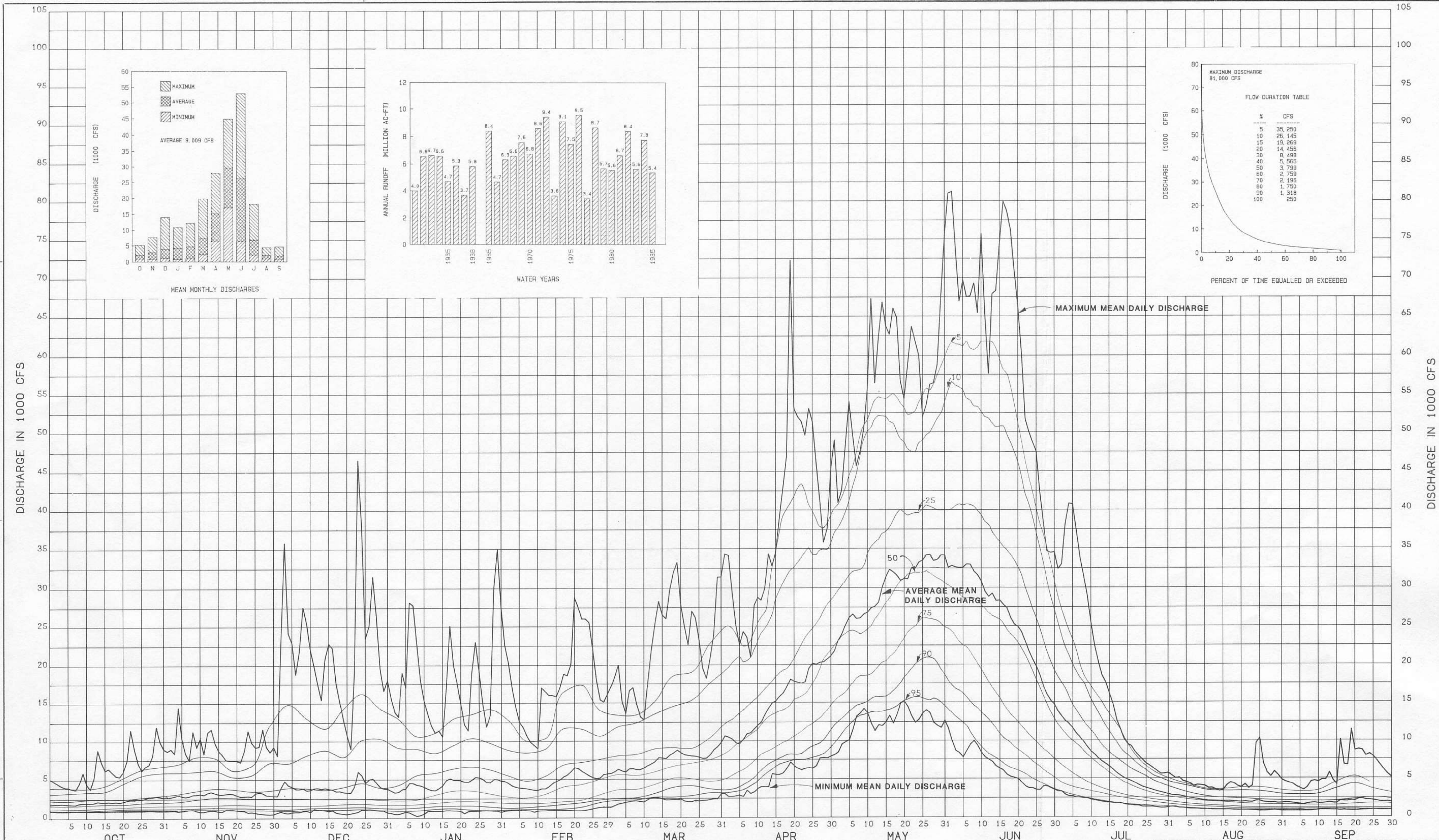
CLEARWATER RIVER BASIN, IDAHO

## MEAN DAILY
## TOTAL UNREGULATED INFLOW

PERIOD OF RECORD: 10/1926 - 9/1985

SUPERVISED:
CHIEF, HYDROLOGY BRANCH
SUBMITTED:
CHIEF, PLANNING DIVISION

APPROVED: DATE
SCALE AS SHOWN | INV. NO. ENG.
FILE NO.
SHEET 4 OF 4




FLOW DURATION TABLE

| % | CFS |
|---|---|
| 5 | 35,250 |
| 10 | 26,145 |
| 15 | 19,269 |
| 20 | 14,456 |
| 30 | 8,498 |
| 40 | 5,565 |
| 50 | 3,799 |
| 60 | 2,759 |
| 70 | 2,196 |
| 80 | 1,750 |
| 90 | 1,318 |
| 100 | 250 |

NOTES

1. RECORDS USED:

   Water years 1931-1938 and 1965-1985, observed discharges for the Clearwater River at Orfino, Idaho.
   Discharge records used are from data published by U.S.G.S.

2. Drainage area is 5,580 square miles.

3. Curves of percent chance of occurrence represent the average flow for that day. A point on an exceedence curve represents the average daily discharge for a specific day which has been exceeded the given percentage of time.

MAXIMUM ANNUAL MEAN DAILY DISCHARGES

| Water Year | Date | CFS | Water Year | Date | CFS |
|---|---|---|---|---|---|
| 1931 | May 17 | 38,600 | 1971 | May 13 | 62,300 |
| 1932 | May 14 | 66,800 | 1972 | Jun 2 | 81,200 |
| 1933 | Jun 10 | 75,700 | 1973 | May 18 | 33,500 |
| 1934 | Dec 23 | 46,500 | 1974 | Jun 16 | 79,900 |
| 1935 | May 24 | 42,900 | 1975 | Jun 3 | 64,000 |
| 1936 | May 15 | 63,700 | 1976 | May 11 | 67,300 |
| 1937 | May 20 | 33,800 | 1977 | May 2 | 28,600 |
| 1938 | Apr 19 | 72,300 | 1978 | Jun 7 | 47,600 |
| 1964 | ------ | ------ | 1979 | May 24 | 52,000 |
| 1965 | Apr 21 | 52,000 | 1980 | May 26 | 37,300 |
| 1966 | May 7 | 39,200 | 1981 | Jun 20 | 44,900 |
| 1967 | May 23 | 61,800 | 1982 | Jun 17 | 57,300 |
| 1968 | Jun 3 | 38,900 | 1983 | May 30 | 47,500 |
| 1969 | May 14 | 46,100 | 1984 | May 31 | 65,800 |
| 1970 | Jun 6 | 62,300 | 1985 | May 25 | 45,500 |

REVISION | DATE | DESCRIPTION | BY

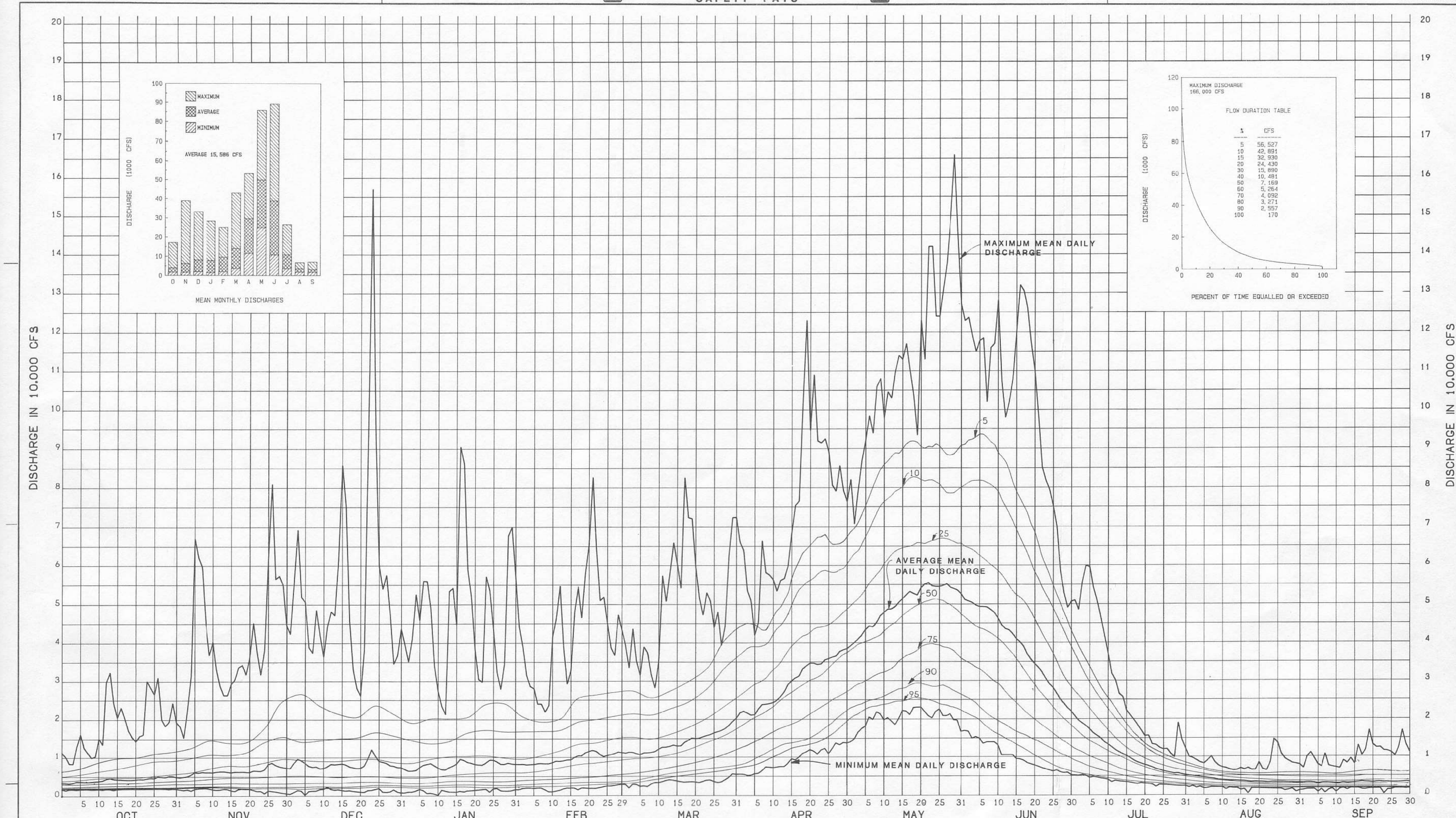
U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

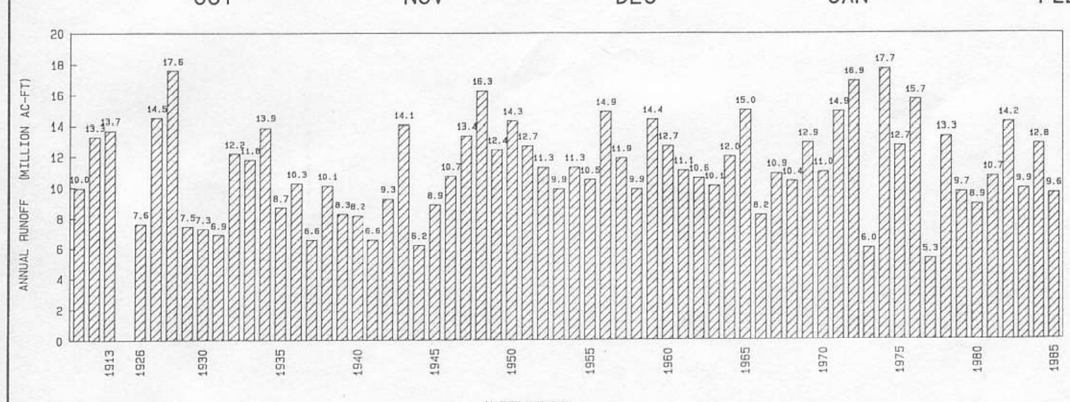
DESIGNED:
DRAWN: Gerber Plotter
CHECKED:
SUPERVISED:
CHIEF
SUBMITTED:
CHIEF.

# DWORSHAK DAM AND RESERVOIR
NORTH FORK CLEARWATER RIVER, IDAHO

## SUMMARY HYDROGRAPHS
## CLEARWATER RIVER AT OROFINO, IDAHO
UNREGULATED DISCHARGE

DATE
SCALE AS SHOWN | INV. NO.
FILE NO.
SHEET




NOTES

1. RECORDS USED:

   a. Water years 1911-1913 and 1926-1971, observed unregulated discharges for Clearwater River at Spalding, Idaho. (Data published by U.S.G.S.).

   b. Water years 1972-1985, unregulated discharges computed by Corps of Engineers, Walla Walla District.

2. Drainage area is 9,570 square miles.

3. Curves of percent chance of occurrence represent the average flow for that day. A point on an exceedence curve represents the average daily discharge for a specific day which has been exceeded the given percentage of time.

MAXIMUM ANNUAL MEAN DAILY DISCHARGES

| Water Year | Date | CFS | Water Year | Date | CFS | Water Year | Date | CFS |
|---|---|---|---|---|---|---|---|---|
| 1911 | May 6 | 59,600 | 1944 | May 16 | 48,400 | 1965 | Apr 21 | 109,000 |
| 1912 | May 30 | 92,300 | 1945 | May 6 | 74,300 | 1966 | May 7 | 63,600 |
| 1913 | May 28 | 98,800 | 1946 | May 6 | 63,300 | 1967 | May 23 | 92,000 |
| 1926 | Apr 19 | 59,700 | 1947 | May 9 | 108,000 | 1968 | Feb 20 | 65,500 |
| 1927 | Jun 9 | 106,000 | 1948 | May 29 | 166,000 | 1969 | May 13 | 71,100 |
| 1928 | May 26 | 104,000 | 1949 | May 16 | 117,000 | 1970 | Jun 6 | 87,800 |
| 1929 | May 24 | 73,300 | 1950 | Jun 17 | 91,900 | 1971 | May 13 | 100,000 |
| 1930 | Apr 25 | 51,000 | 1951 | May 12 | 70,400 | 1972 | Jun 2 | 123,700 |
| 1931 | Apr 1 | 66,100 | 1952 | Apr 28 | 85,600 | 1973 | May 18 | 47,700 |
| 1932 | May 14 | 114,000 | 1953 | Jun 13 | 75,600 | 1974 | Jun 16 | 132,000 |
| 1933 | Jun 10 | 128,000 | 1954 | May 20 | 97,600 | 1975 | Jun 3 | 98,700 |
| 1934 | Dec 23 | 157,000 | 1955 | Jun 12 | 94,800 | 1976 | May 11 | 104,600 |
| 1935 | May 24 | 69,400 | 1956 | May 21 | 112,000 | 1977 | May 2 | 42,100 |
| 1936 | May 15 | 101,000 | 1957 | May 20 | 123,000 | 1978 | Dec 3 | 69,300 |
| 1937 | May 19 | 60,900 | 1958 | May 22 | 85,300 | 1979 | May 6 | 98,400 |
| 1938 | Apr 19 | 123,000 | 1959 | Jun 6 | 76,900 | 1980 | Apr 29 | 58,100 |
| 1939 | May 4 | 73,400 | 1960 | May 13 | 74,700 | 1981 | Jun 20 | 63,400 |
| 1940 | May 12 | 53,500 | 1961 | May 27 | 87,000 | 1982 | Feb 21 | 82,700 |
| 1941 | May 14 | 37,400 | 1962 | Apr 7 | 66,400 | 1983 | May 29 | 73,100 |
| 1942 | May 26 | 49,300 | 1963 | May 25 | 56,100 | 1984 | May 31 | 98,300 |
| 1943 | May 28 | 82,800 | 1964 | Jun 9 | 117,000 | 1985 | May 25 | 71,000 |

| REVISION | DATE | DESCRIPTION | CHKD | APPR |
|---|---|---|---|---|

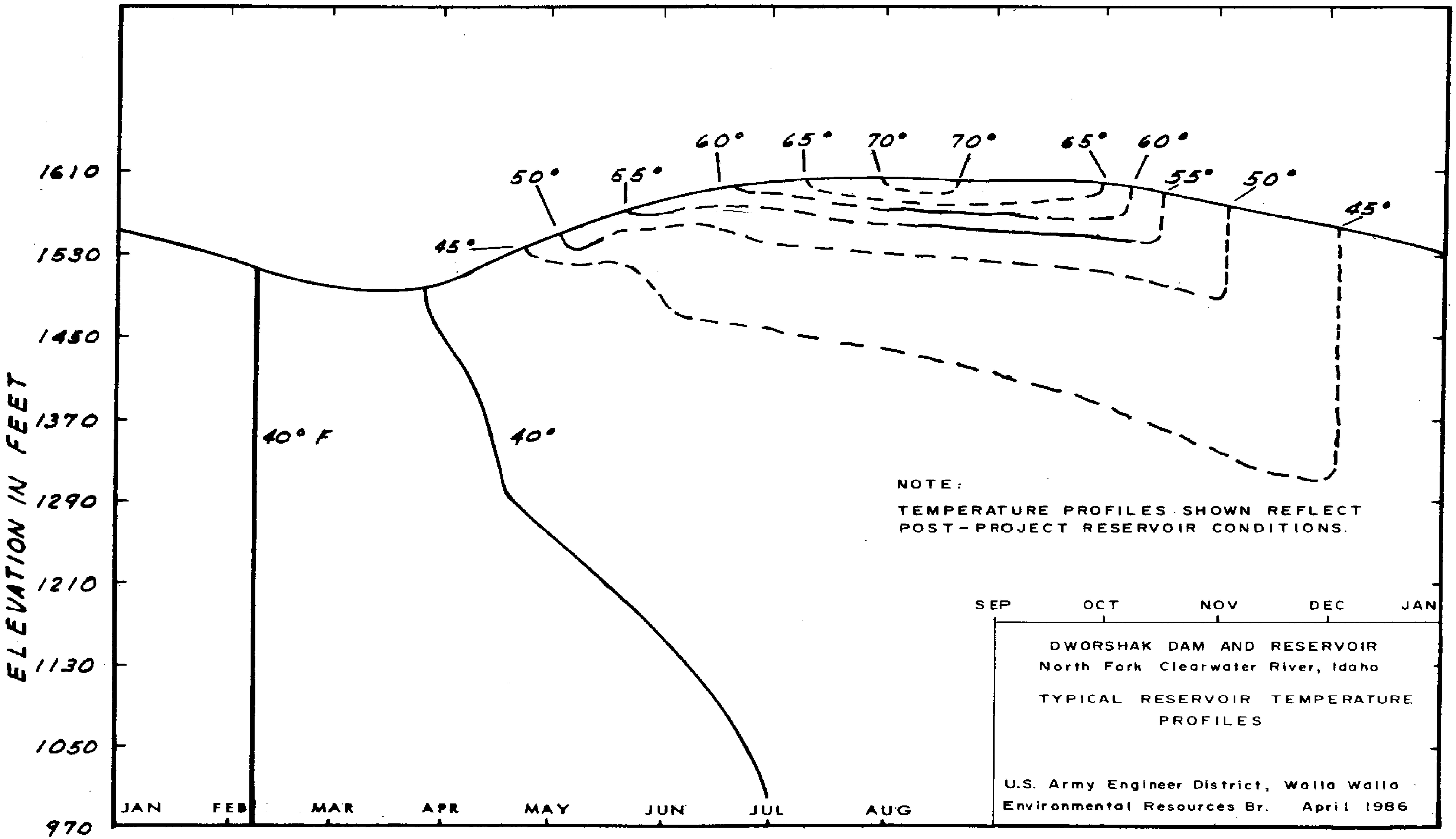
U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

DESIGNED BY
Gerber Plotter
DRAWN BY
CHECKED BY
SUPERVISED:
CHIEF, HYDROLOGY BRANCH

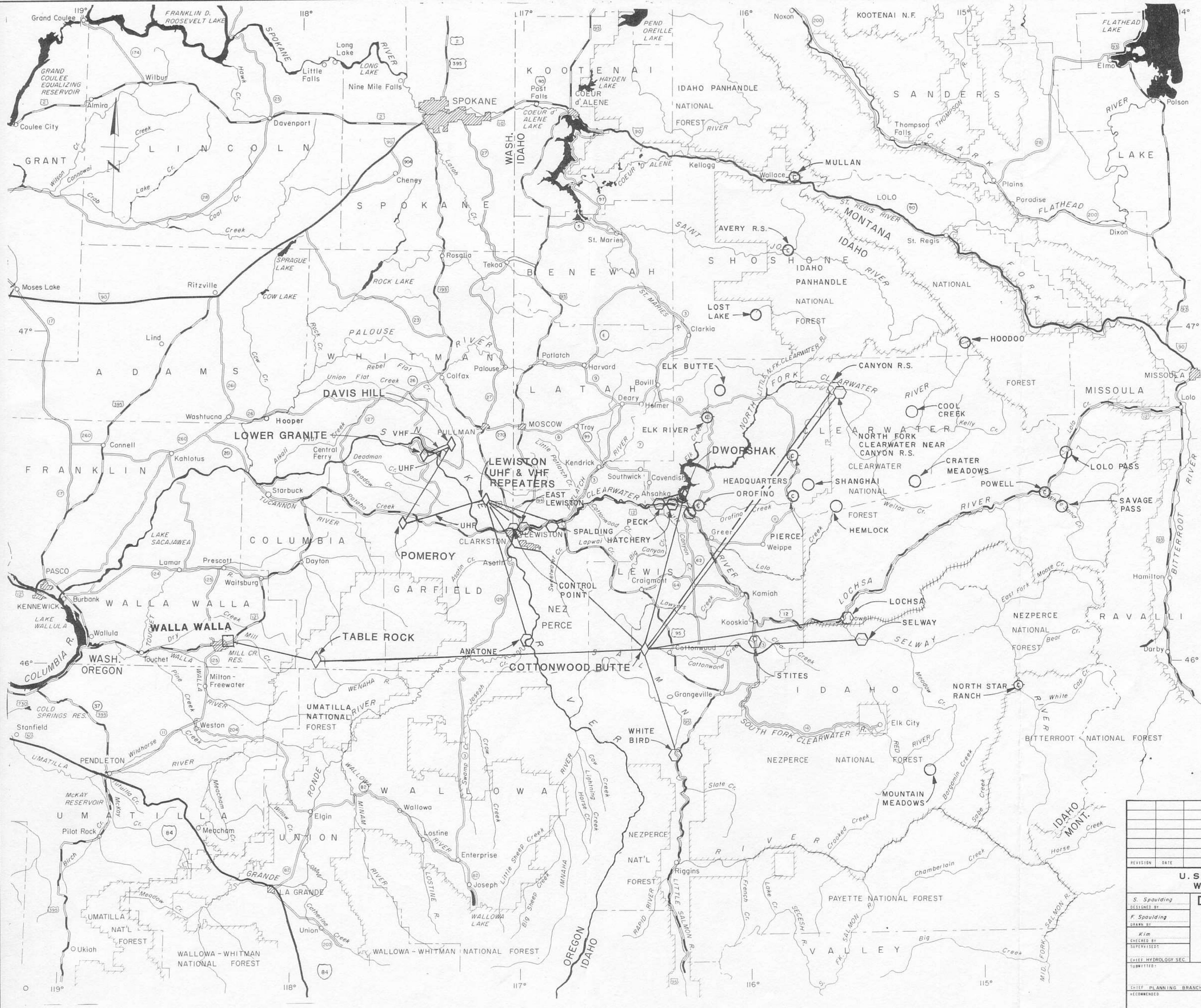
# DWORSHAK DAM AND RESERVOIR
NORTH FORK CLEARWATER RIVER, IDAHO

## SUMMARY HYDROGRAPHS
## CLEARWATER RIVER AT SPALDING, IDAHO
UNREGULATED DISCHARGE

SUBMITTED:
CHIEF PLANNING DIVISION
RECOMMENDED
CHIEF
APPROVED DATE
SCALE AS SHOWN | INV. NO.
SHEET NO | FILE NO



ELEVATION IN FEET
1610
1530
1450
1370
1290
1210
1130
1050
970
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
40° F
40°
45°
50°
55°
60°
65°
70°
70°
65°
60°
55°
50°
45°
NOTE:
TEMPERATURE PROFILES SHOWN REFLECT POST-PROJECT RESERVOIR CONDITIONS.
DWORSHAK DAM AND RESERVOIR
North Fork Clearwater River, Idaho
TYPICAL RESERVOIR TEMPERATURE PROFILES
U.S. Army Engineer District, Walla Walla
Environmental Resources Br. April 1986




LEGEND

- WALLA WALLA BASE STATION (USCE)
- RELAY TOWER (USCE)
  - COTTONWOOD BUTTE
  - DAVIS HILL
  - DWORSHAK
  - LEWISTON
  - LOWER GRANITE
  - POMEROY
  - TABLE ROCK
- RIVER STATION (USGS AND USCE)
  - ANATONE
  - CANYON R.S.
  - CONTROL POINT
  - EAST LEWISTON
  - HATCHERY
  - LOCHSA (LOWELL)
  - OROFINO
  - PECK
  - SELWAY (LOWELL)
  - SPALDING
  - STITES
  - WHITE BIRD
- SNOW SITE (SCS SNOTEL)
  - COOL CREEK
  - CRATER MEADOWS
  - ELK BUTTE
  - HEMLOCK
  - HOODOO
  - LOLO PASS
  - LOST LAKE
  - MOUNTAIN MEADOWS
  - SAVAGE PASS
  - SHANGHAI
- CLIMATOLOGICAL STATION (NOAA)
  - AVERY R.S.
  - ELK RIVER
  - HEADQUARTERS
  - MULLAN
  - NORTH STAR RANCH
  - OROFINO
  - PIERCE
  - POWELL

NOTES:

1. DWORSHAK DAM AND RESERVOIR DISCHARGES ARE TRANSMITTED VIA THE COLUMBIA RIVER BASIN TELETYPE (CBT) SYSTEM INSTEAD OF THE HYDROMET NETWORK.
2. CONTROL POINT AND EAST LEWISTON RIVER STATIONS TRANSMIT STAGE MEASUREMENTS ONLY. HATCHERY RIVER STATION TRANSMITS WATER TEMPERATURE ONLY.
3. THE MOUNTAIN MEADOWS SNOW SITE IS NOT PRESENTLY USED IN BASIN VOLUME FORECASTING, BUT IT HAS THE POTENTIAL FOR FUTURE USE.
4. ALL OF THE LISTED STATIONS RECEIVE AT LEAST PARTIAL FUNDING FROM THE CORPS OF ENGINEERS EXCEPT THE LOST LAKE AND MOUNTAIN MEADOWS SNOW SITES.

| REVISION | DATE | DESCRIPTION | CHKD | APPR |
|---|---|---|---|---|

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

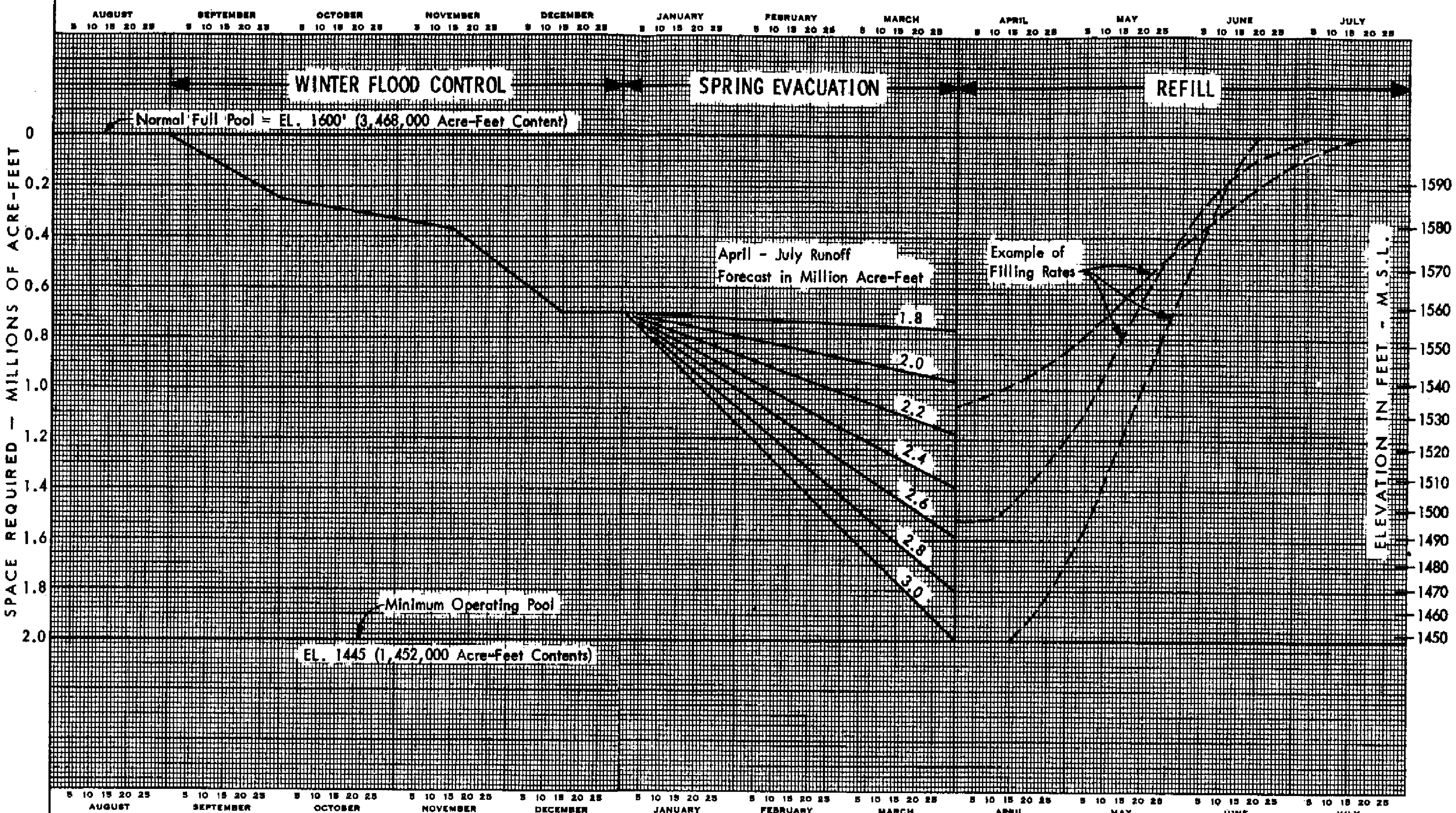
# DWORSHAK DAM AND RESERVOIR

NORTH FORK CLEARWATER RIVER, IDAHO

## AUTOMATED HYDROMET NETWORK

LOCATION MAP

S. Spoulding — DESIGNED BY
F. Spoulding — DRAWN BY
Kim — CHECKED BY
SUPERVISED: CHIEF HYDROLOGY SEC.
SUBMITTED: CHIEF PLANNING BRANCH
RECOMMENDED: CHIEF
APPROVED DATE
SCALE AS SHOWN | INV. NO.
SHEET NO | FILE NO




## NOTES:

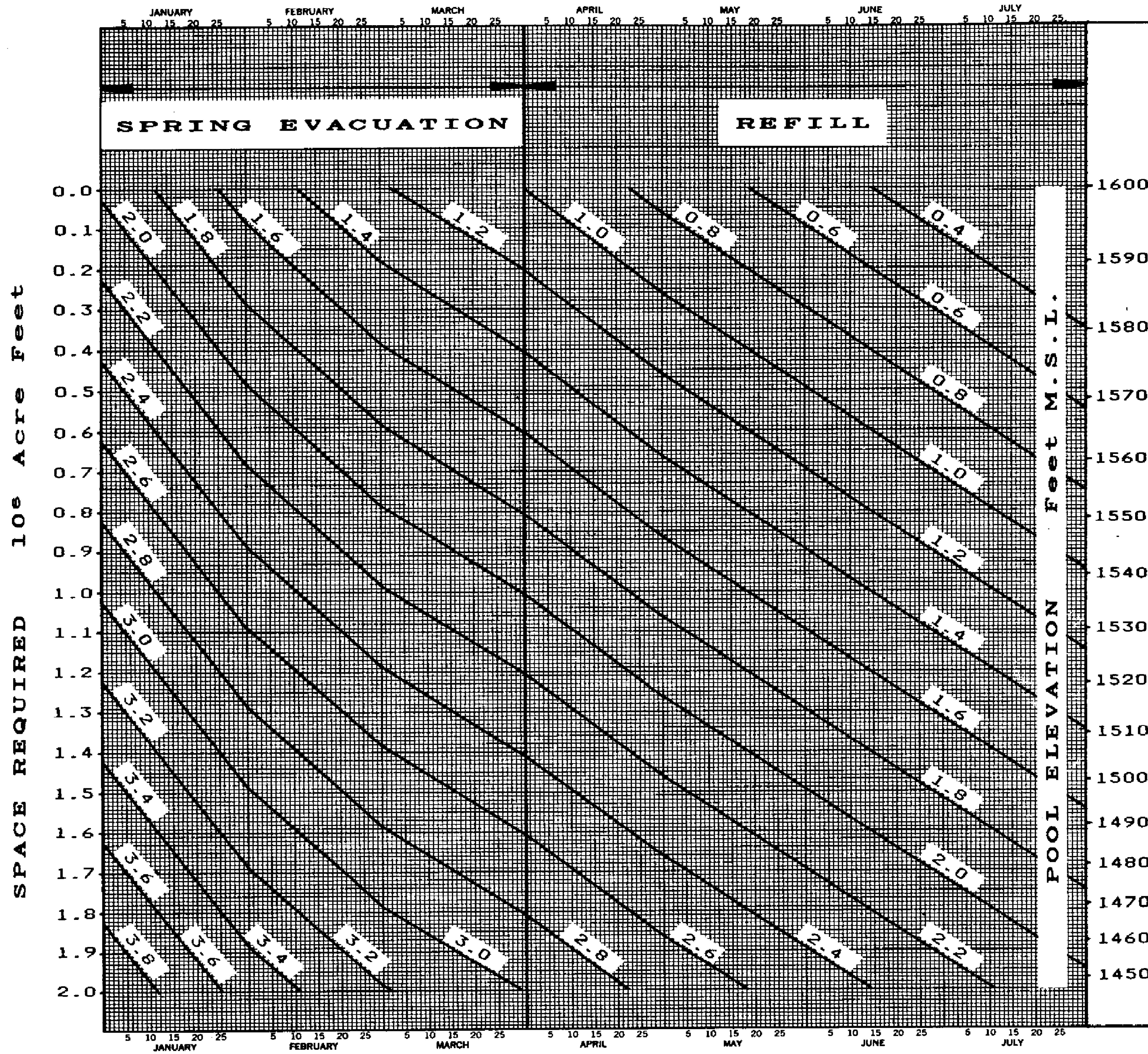
1. These curves are to be used with the forecast procedure developed by NPW.
2. Elevation reached on 1 April will be held until:
   a. Forecasts indicate a need to reduce outflow for flood control.
   b. Elevation becomes lower than the variable refill curve computed on a daily basis.
3. Release during flood control operation will be 4,000 cfs unless forecasts indicate that significant spilling will result when reservoir fills. In such a case, outflows may be increased to plant capacity. This rule applies only when reservoir is above variable refill curve.
4. The following minimum space must be retained when space is less than 700,000 A.F., unless reservoir is below variable refill curve:

| Percent of Area Covered by Accumulated Winter Snowpack | Minimum Space 1,000 Ac. Ft. |
|---|---|
| 100 | 700 |
| 80 | 540 |
| 60 | 385 |
| 40 | 230 |
| 20 | 80 |
| 10 | 0 |

DWORSHAK DAM AND RESERVOIR
North Fork Clearwater River, Idaho

OPERATING CURVES FOR FLOOD CONTROL

U. S. Army Engineer District, Walla Walla
Hydrology Branch February 1986




**NOTES**

1. The variable refill curves (VRC) have the following corrections built in to assure 95% refill and provide a mean daily release of 2,000 cfs from forecast date through 31 July.

**Forecast correction applied to most probable forecast = 1.645 x standard error for period of forecast:**

| <u>1 Jan Fcst</u> | <u>1 Feb Fcst</u> | <u>1 Mar Fcst</u> |
|---|---|---|
| 1,129,100 AF | 797,700 AF | 609,500 AF |
| <u>1 Apr Fcst</u> | <u>1 May Fcst</u> | <u>1 Jun Fcst</u> |
| 511,100 AF | 374,200 AF | 265,200 AF |

The forecast correction is applied to the most probable forecast when computing the VRC.

**The volume correction required for a 2,000 cfs mean daily release from forecast date through 31 July is as follows:**

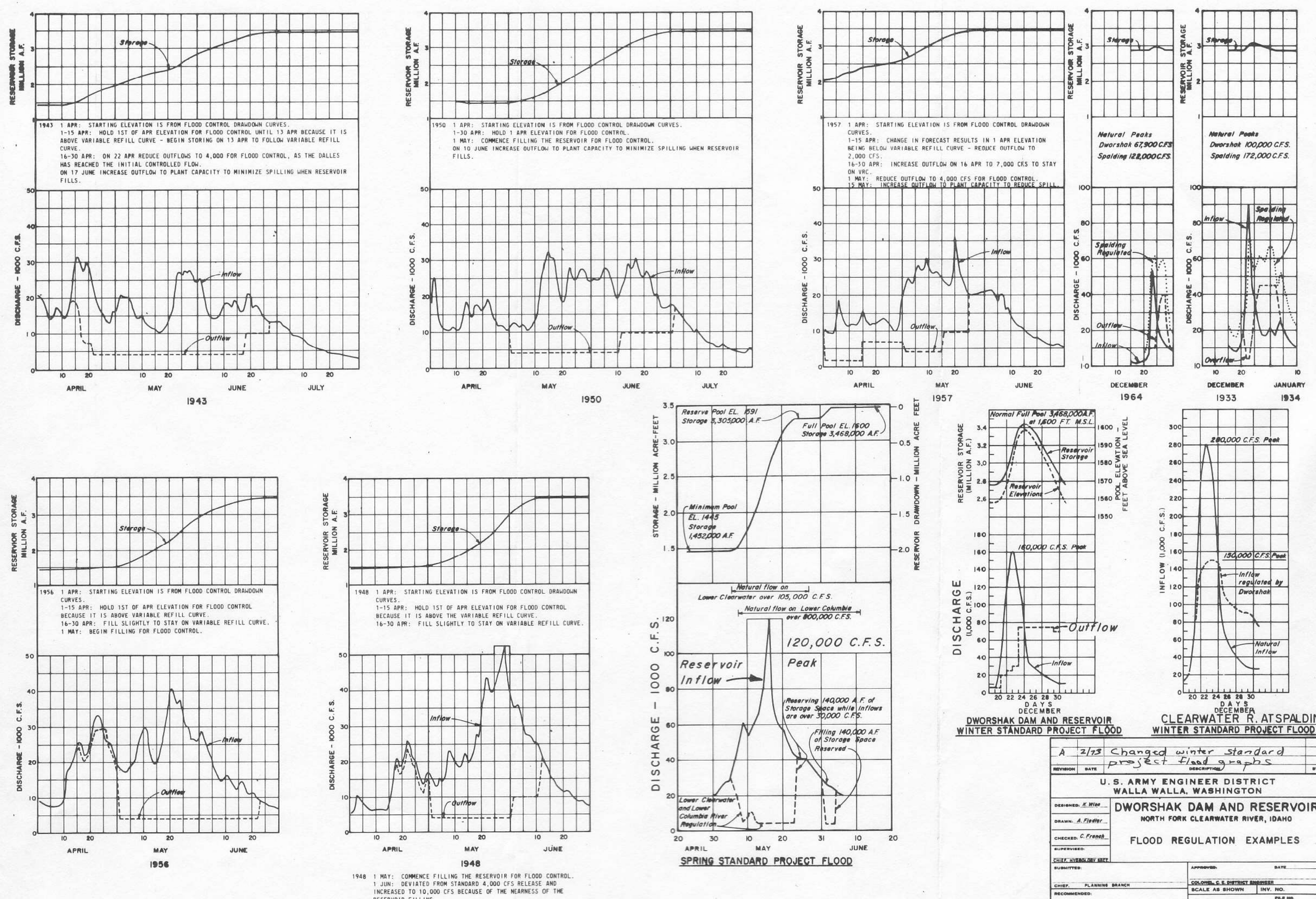
| <u>1 Jan Fcst</u> | <u>1 Feb Fcst</u> | <u>1 Mar Fcst</u> |
|---|---|---|
| 841,000 AF | 718,000 AF | 606,900 AF |
| <u>1 Apr Fcst</u> | <u>1 May Fcst</u> | <u>1 Jun Fcst</u> |
| 484,000 AF | 365,000 AF | 242,000 AF |

2. The VRC curves are used as follows: Enter on the date of the forecast and follow the date line to its intersection with the VRC equal to the most probable volume from date to 31 July. Then read the space required from the vertical scale on the left margin. This is the space that has a 95% probability of refill with a mean daily release of 2,000 cfs.

DWORSHAK DAM AND RESERVOIR
North Fork Clearwater River, Idaho

**VARIABLE REFILL CURVES**
**BASED ON NPW FORECASTS**

U.S. Army Engineer District, Walla Walla
Hydrology Branch January, 1986



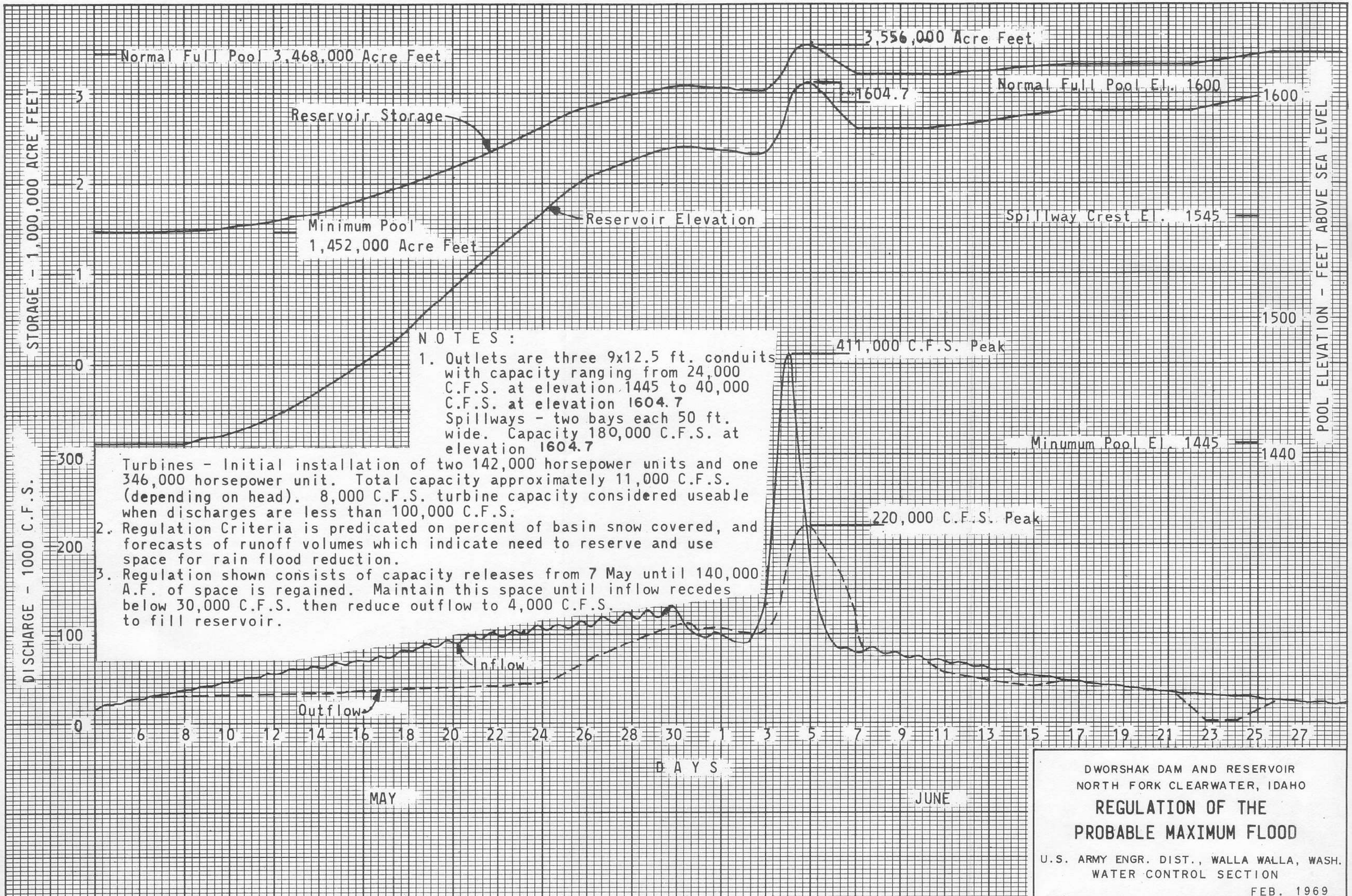

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|
| A | 2/73 | Changed winter standard project flood graphs | |

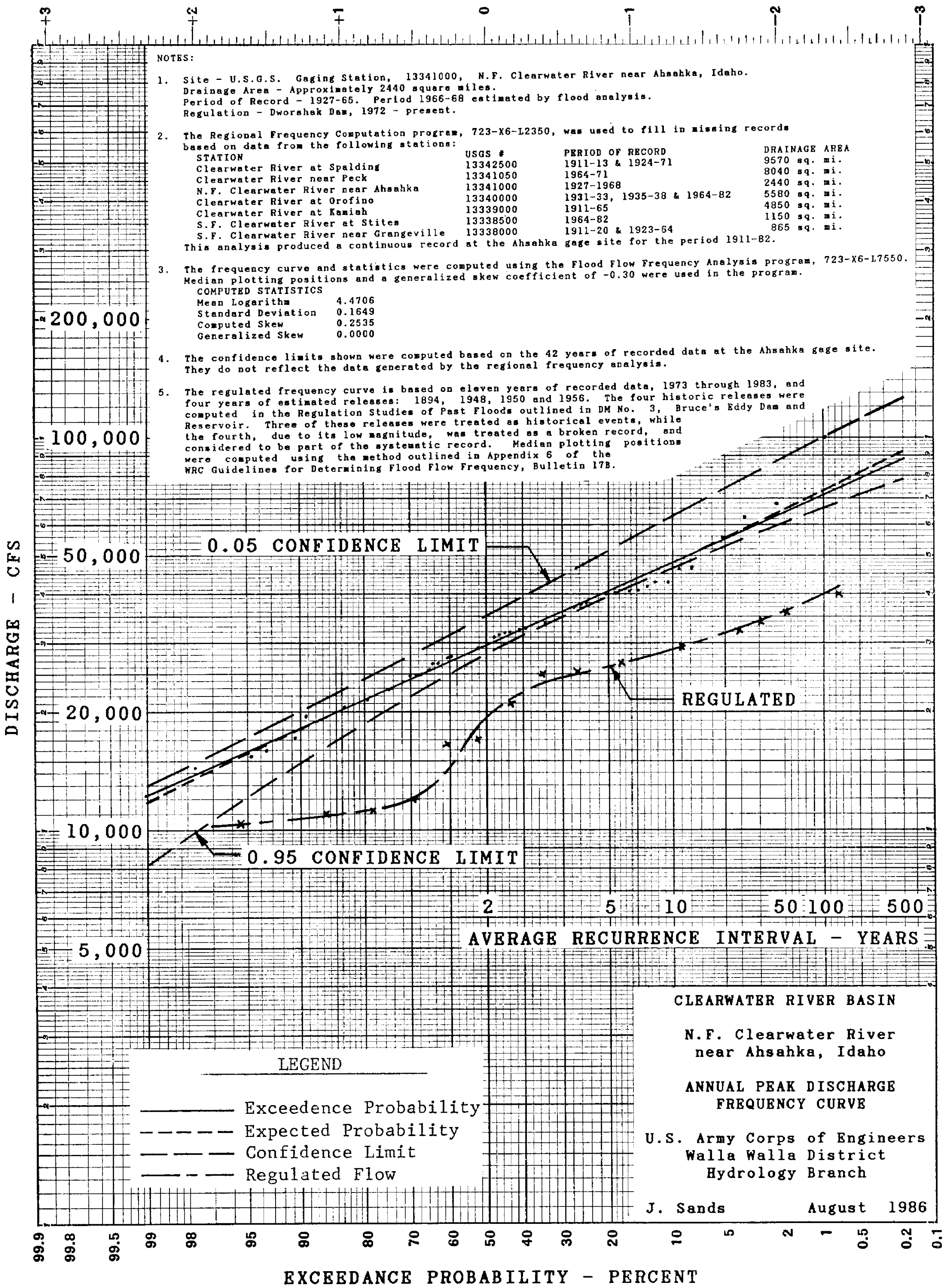
U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

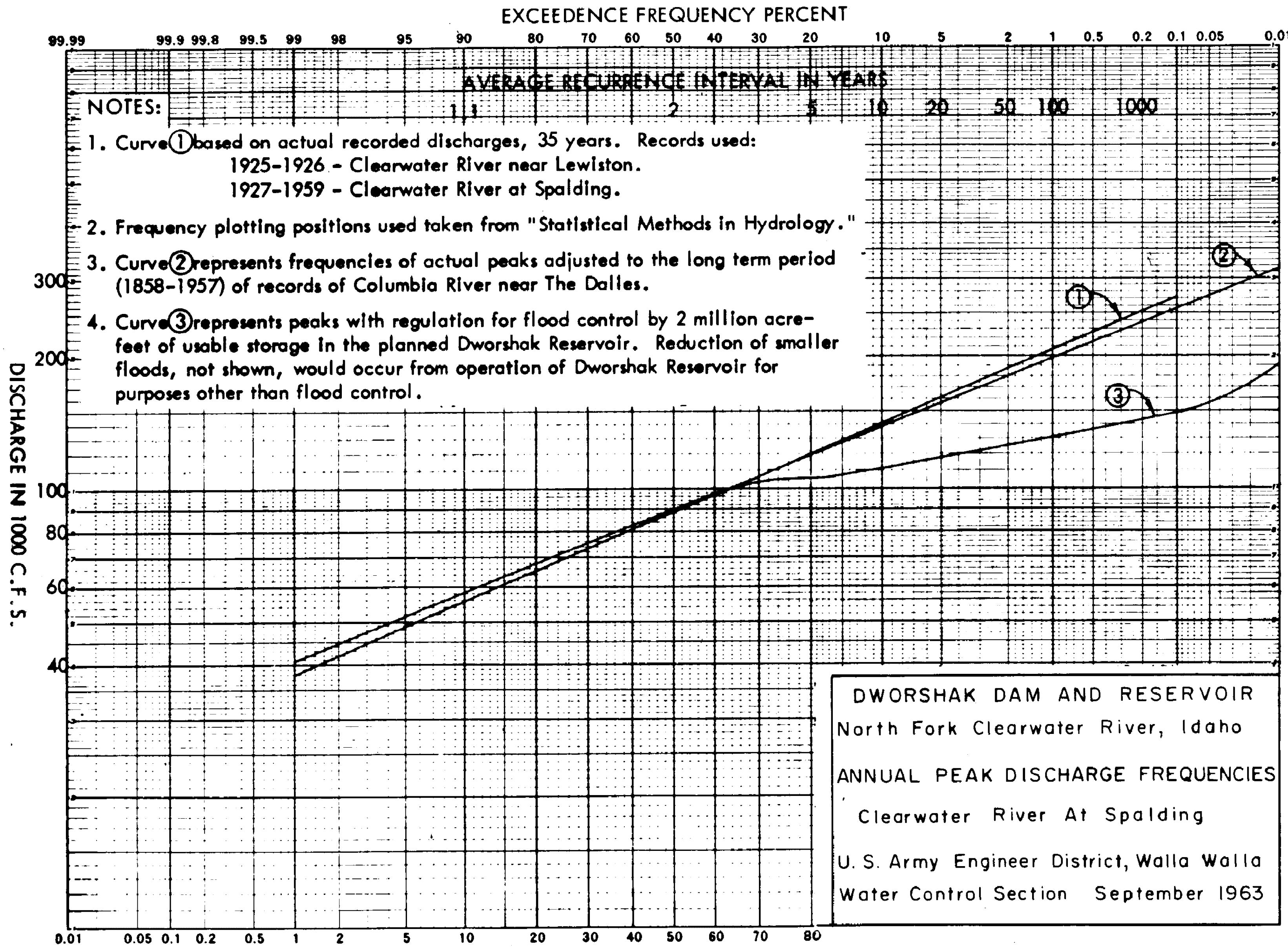
## DWORSHAK DAM AND RESERVOIR
NORTH FORK CLEARWATER RIVER, IDAHO

## FLOOD REGULATION EXAMPLES

DESIGNED: K. Wise
DRAWN: A. Fiedler
CHECKED: C. French
SUPERVISED:
CHIEF, HYDROLOGY SECT.
SUBMITTED:
CHIEF, PLANNING BRANCH
RECOMMENDED:
CHIEF, ENGINEERING DIVISION
APPROVED: DATE
COLONEL, C. E. DISTRICT ENGINEER
SCALE AS SHOWN | INV. NO.
FILE NO.
SHEET


Normal Full Pool 3,468,000 Acre Feet
3,556,000 Acre Feet
1604.7
Normal Full Pool El. 1600
Reservoir Storage
Reservoir Elevation
Minimum Pool
1,452,000 Acre Feet
Spillway Crest El. 1545
Minumum Pool El. 1445
411,000 C.F.S. Peak
220,000 C.F.S. Peak
Inflow
Outflow
STORAGE - 1,000,000 ACRE FEET
DISCHARGE - 1000 C.F.S.
POOL ELEVATION - FEET ABOVE SEA LEVEL
3
2
1
0
300
200
100
0
1600
1500
1440
6 8 10 12 14 16 18 20 22 24 26 28 30 1 3 5 7 9 11 13 15 17 19 21 23 25 27
DAYS
MAY
JUNE
NOTES:
1. Outlets are three 9x12.5 ft. conduits with capacity ranging from 24,000 C.F.S. at elevation 1445 to 40,000 C.F.S. at elevation 1604.7
Spillways - two bays each 50 ft. wide. Capacity 180,000 C.F.S. at elevation 1604.7
Turbines - Initial installation of two 142,000 horsepower units and one 346,000 horsepower unit. Total capacity approximately 11,000 C.F.S. (depending on head). 8,000 C.F.S. turbine capacity considered useable when discharges are less than 100,000 C.F.S.
2. Regulation Criteria is predicated on percent of basin snow covered, and forecasts of runoff volumes which indicate need to reserve and use space for rain flood reduction.
3. Regulation shown consists of capacity releases from 7 May until 140,000 A.F. of space is regained. Maintain this space until inflow recedes below 30,000 C.F.S. then reduce outflow to 4,000 C.F.S. to fill reservoir.
DWORSHAK DAM AND RESERVOIR
NORTH FORK CLEARWATER, IDAHO
REGULATION OF THE
PROBABLE MAXIMUM FLOOD
U.S. ARMY ENGR. DIST., WALLA WALLA, WASH.
WATER CONTROL SECTION
FEB. 1969

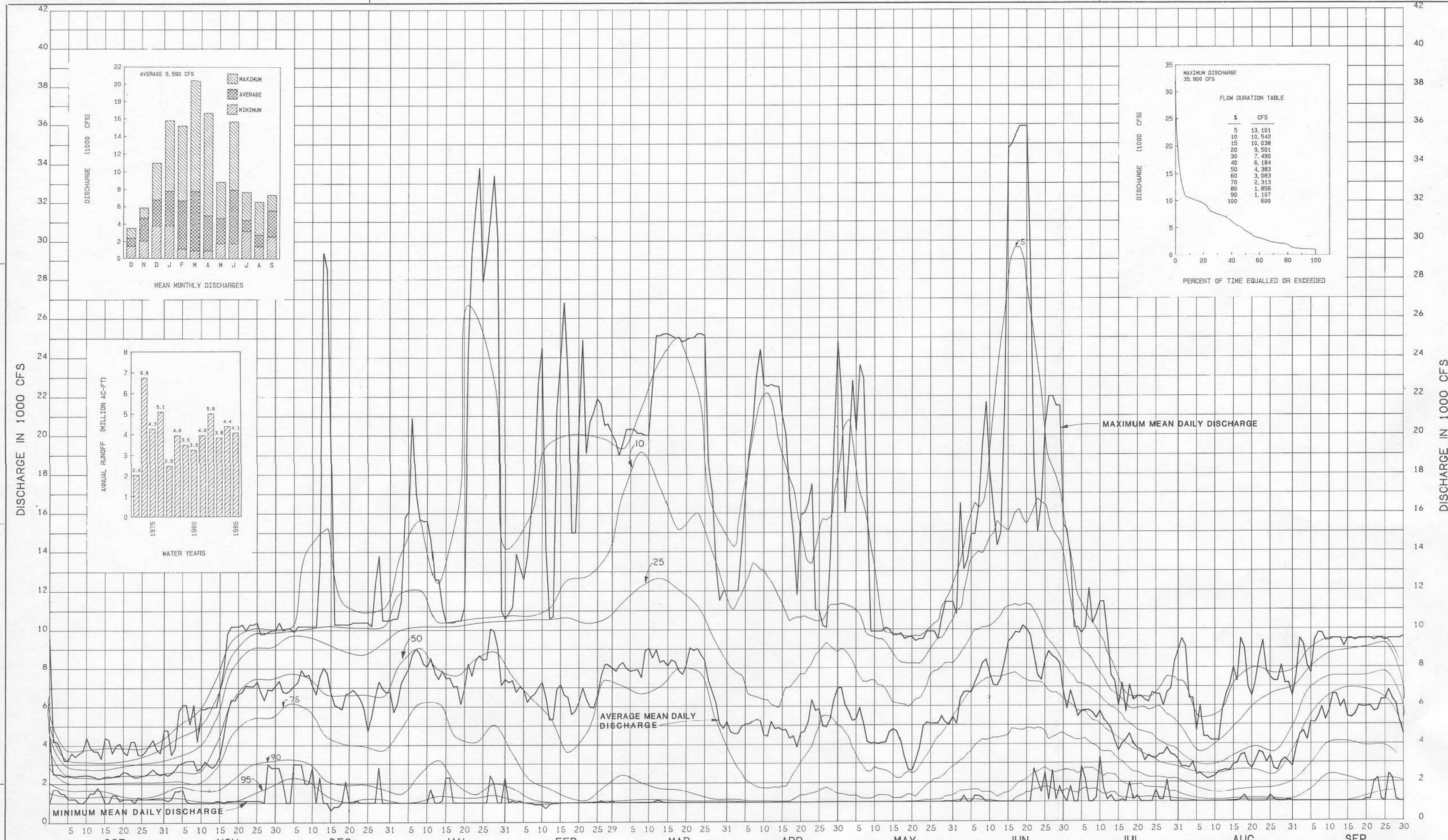

NOTES:
1. Site - U.S.G.S. Gaging Station, 13341000, N.F. Clearwater River near Ahsahka, Idaho.
Drainage Area - Approximately 2440 square miles.
Period of Record - 1927-65. Period 1966-68 estimated by flood analysis.
Regulation - Dworshak Dam, 1972 - present.
2. The Regional Frequency Computation program, 723-X6-L2350, was used to fill in missing records based on data from the following stations:
STATION | USGS # | PERIOD OF RECORD | DRAINAGE AREA
Clearwater River at Spalding | 13342500 | 1911-13 & 1924-71 | 9570 sq. mi.
Clearwater River near Peck | 13341050 | 1964-71 | 8040 sq. mi.
N.F. Clearwater River near Ahsahka | 13341000 | 1927-1968 | 2440 sq. mi.
Clearwater River at Orofino | 13340000 | 1931-33, 1935-38 & 1964-82 | 5580 sq. mi.
Clearwater River at Kamiah | 13339000 | 1911-65 | 4850 sq. mi.
S.F. Clearwater River at Stites | 13338500 | 1964-82 | 1150 sq. mi.
S.F. Clearwater River near Grangeville | 13338000 | 1911-20 & 1923-64 | 865 sq. mi.
This analysis produced a continuous record at the Ahsahka gage site for the period 1911-82.
3. The frequency curve and statistics were computed using the Flood Flow Frequency Analysis program, 723-X6-L7550. Median plotting positions and a generalized skew coefficient of -0.30 were used in the program.
COMPUTED STATISTICS
Mean Logarithm 4.4706
Standard Deviation 0.1649
Computed Skew 0.2535
Generalized Skew 0.0000
4. The confidence limits shown were computed based on the 42 years of recorded data at the Ahsahka gage site. They do not reflect the data generated by the regional frequency analysis.
5. The regulated frequency curve is based on eleven years of recorded data, 1973 through 1983, and four years of estimated releases: 1894, 1948, 1950 and 1956. The four historic releases were computed in the Regulation Studies of Past Floods outlined in DM No. 3, Bruce's Eddy Dam and Reservoir. Three of these releases were treated as historical events, while the fourth, due to its low magnitude, was treated as a broken record, and considered to be part of the systematic record. Median plotting positions were computed using the method outlined in Appendix 6 of the WRC Guidelines for Determining Flood Flow Frequency, Bulletin 17B.
+3 +2 +1 0 -1 -2 -3
200,000
100,000
50,000
20,000
10,000
5,000
DISCHARGE - CFS
0.05 CONFIDENCE LIMIT
REGULATED
0.95 CONFIDENCE LIMIT
2 5 10 50 100 500
AVERAGE RECURRENCE INTERVAL - YEARS
LEGEND
Exceedence Probability
Expected Probability
Confidence Limit
Regulated Flow
CLEARWATER RIVER BASIN
N.F. Clearwater River near Ahsahka, Idaho
ANNUAL PEAK DISCHARGE FREQUENCY CURVE
U.S. Army Corps of Engineers
Walla Walla District
Hydrology Branch
J. Sands August 1986
99.9 99.8 99.5 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1
EXCEEDANCE PROBABILITY - PERCENT


EXCEEDENCE FREQUENCY PERCENT
AVERAGE RECURRENCE INTERVAL IN YEARS
DISCHARGE IN 1000 C.F.S.
NOTES:
1. Curve 1 based on actual recorded discharges, 35 years. Records used:
1925-1926 - Clearwater River near Lewiston.
1927-1959 - Clearwater River at Spalding.
2. Frequency plotting positions used taken from "Statistical Methods in Hydrology."
3. Curve 2 represents frequencies of actual peaks adjusted to the long term period (1858-1957) of records of Columbia River near The Dalles.
4. Curve 3 represents peaks with regulation for flood control by 2 million acre-feet of usable storage in the planned Dworshak Reservoir. Reduction of smaller floods, not shown, would occur from operation of Dworshak Reservoir for purposes other than flood control.
DWORSHAK DAM AND RESERVOIR
North Fork Clearwater River, Idaho
ANNUAL PEAK DISCHARGE FREQUENCIES
Clearwater River At Spalding
U. S. Army Engineer District, Walla Walla
Water Control Section September 1963

CORPS OF ENGINEERS

SAFETY PAYS

U. S. ARMY




NOTES

1. RECORDS USED:

   Water years 1973-1985, observed Dworshak project discharges. Discharge records used are from project data.

2. Drainage area is 2,440 square miles.

3. Curves of percent chance of occurrence represent the average flow for that day. A point on an exceedence curve represents the average daily discharge for a specific day which has been exceeded the given percentage of time.

MAXIMUM ANNUAL MEAN DAILY DISCHARGES

| Water Year | Date | CFS |
|---|---|---|
| 1973 | Jan 20 | 11,200 |
| 1974 | Jun 18 | 35,900 |
| 1975 | Feb 16 | 26,800 |
| 1976 | Dec 13 | 29,400 |
| 1977 | Jan 27 | 10,400 |
| 1978 | Mar 11 | 11,000 |
| 1979 | Jan 6 | 20,900 |
| 1980 | Jun 2 | 16,500 |
| 1981 | Jun 19 | 17,000 |
| 1982 | Mar 14 | 25,200 |
| 1983 | Mar 10 | 12,000 |
| 1984 | Jun 8 | 18,100 |
| 1985 | Jun 9 | 21,700 |

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

DESIGNED:
DRAWN: Gerber Plotter
CHECKED:
SUPERVISED:
CHIEF, HYDROLOGY BRANCH

# DWORSHAK DAM AND RESERVOIR

NORTH FORK CLEARWATER RIVER, IDAHO

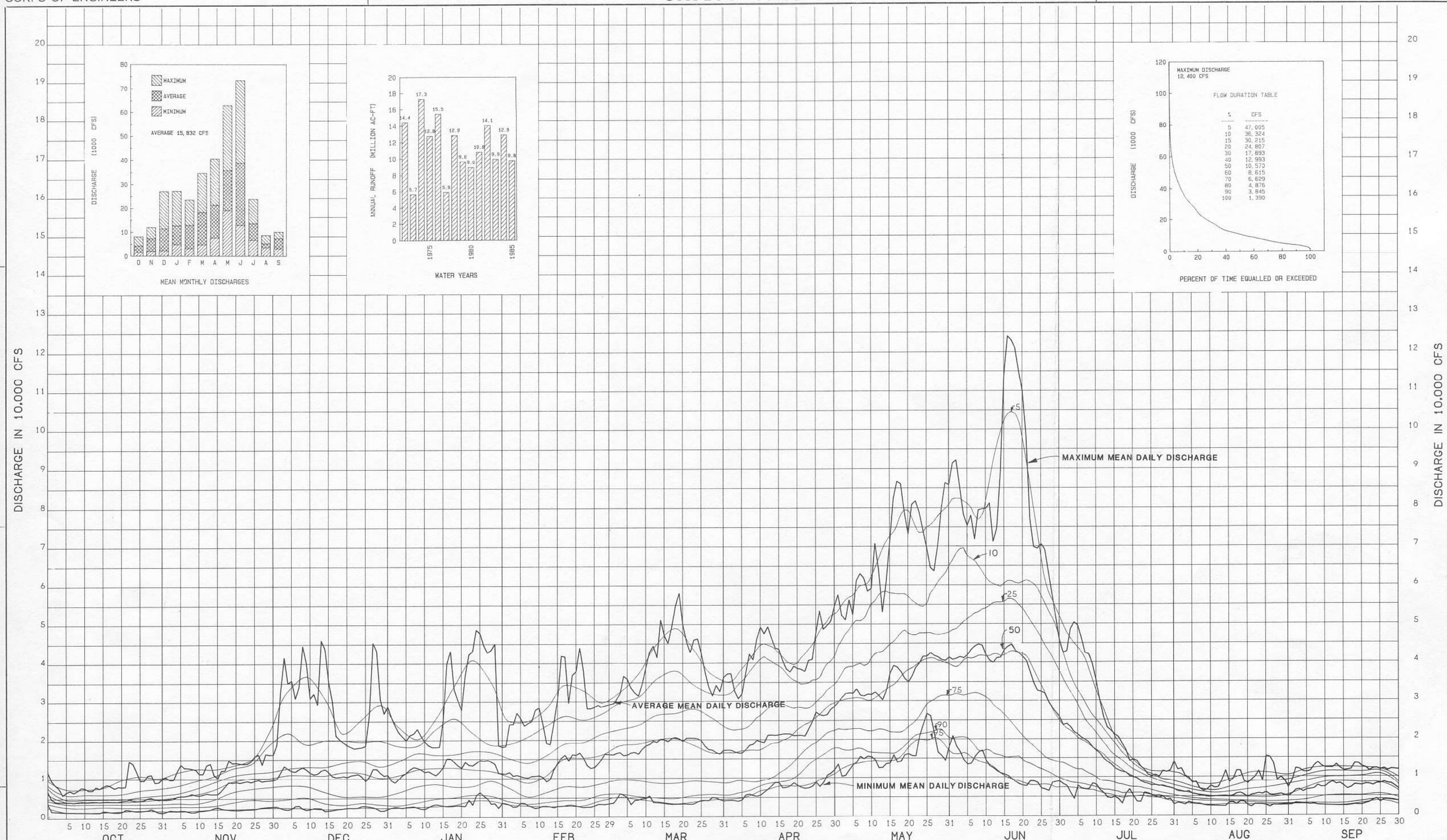
## SUMMARY HYDROGRAPHS

DWORSHAK RESERVOIR NEAR AHSAHKA, IDAHO

REGULATED DISCHARGE

SUBMITTED: DATE
CHIEF, PLANNING DIVISION
SCALE AS SHOWN | INV. NO.
FILE NO.
SHEET

VALUE ENGINEERING PAYS




NOTES

1. RECORDS USED:

   Water years 1972-1985, observed discharges for the Clearwater River at Spalding, Idaho.
   Discharge records used are from data published by U.S.G.S.

2. Drainage area is 9,570 square miles.

3. Curves of percent chance of occurrence represent the average flow for that day. A point on an exceedence curve represents the average daily discharge for a specific day which has been exceeded the given percentage of time.

MAXIMUM ANNUAL MEAN DAILY DISCHARGES

| Water Year | Date | CFS |
|---|---|---|
| 1972 | Jun 2 | 92,200 |
| 1973 | May 18 | 34,200 |
| 1974 | Jun 16 | 124,000 |
| 1975 | Jun 3 | 74,200 |
| 1976 | May 11 | 70,800 |
| 1977 | May 3 | 28,500 |
| 1978 | Jun 7 | 54,000 |
| 1979 | May 24 | 60,700 |
| 1980 | May 26 | 48,200 |
| 1981 | Jun 20 | 64,000 |
| 1982 | Jun 17 | 62,500 |
| 1983 | May 28 | 54,800 |
| 1984 | May 31 | 75,700 |
| 1985 | Jun 8 | 55,100 |

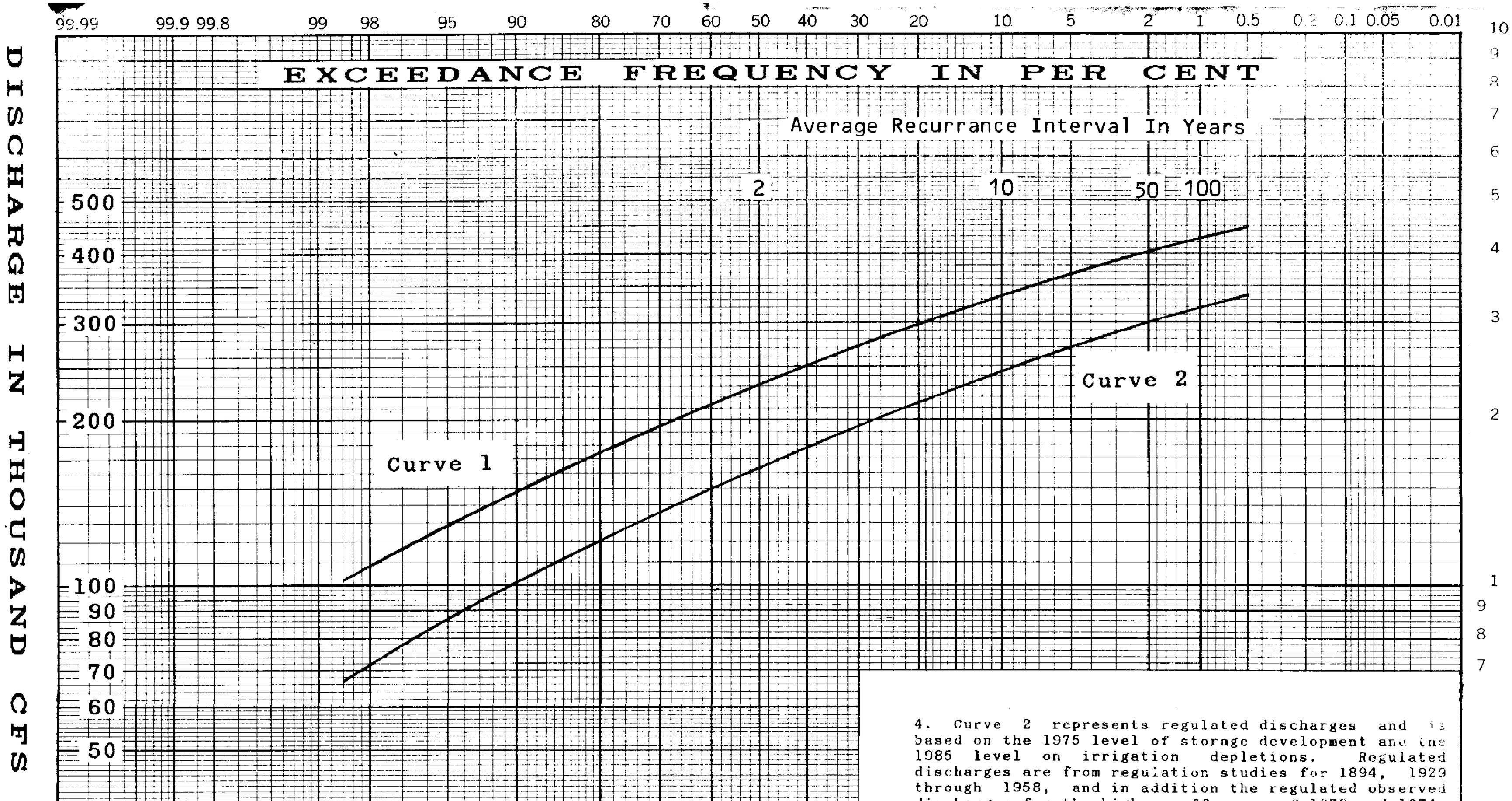
| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

DESIGNED:
DRAWN: Gerber Plotter
CHECKED:
SUPERVISED:
CHIEF, HYDROLOGY BRANCH
SUBMITTED:
CHIEF, PLANNING DIVISION

# DWORSHAK DAM AND RESERVOIR
NORTH FORK CLEARWATER RIVER, IDAHO
## SUMMARY HYDROGRAPHS
## CLEARWATER RIVER AT SPALDING, IDAHO
REGULATED DISCHARGE

DATE
SCALE AS SHOWN | INV. NO.
FILE NO.
SHEET




4. Curve 2 represents regulated discharges and is based on the 1975 level of storage development and the 1985 level on irrigation depletions. Regulated discharges are from regulation studies for 1894, 1929 through 1958, and in addition the regulated observed discharges for the high runoff years of 1972 and 1974. The plotting positions for the regulated event years are for the natural frequency curve. Curve 2 is a graphical fit of the regulated data.

NOTES

1. Drainage area equals 103,200 sq. mi.

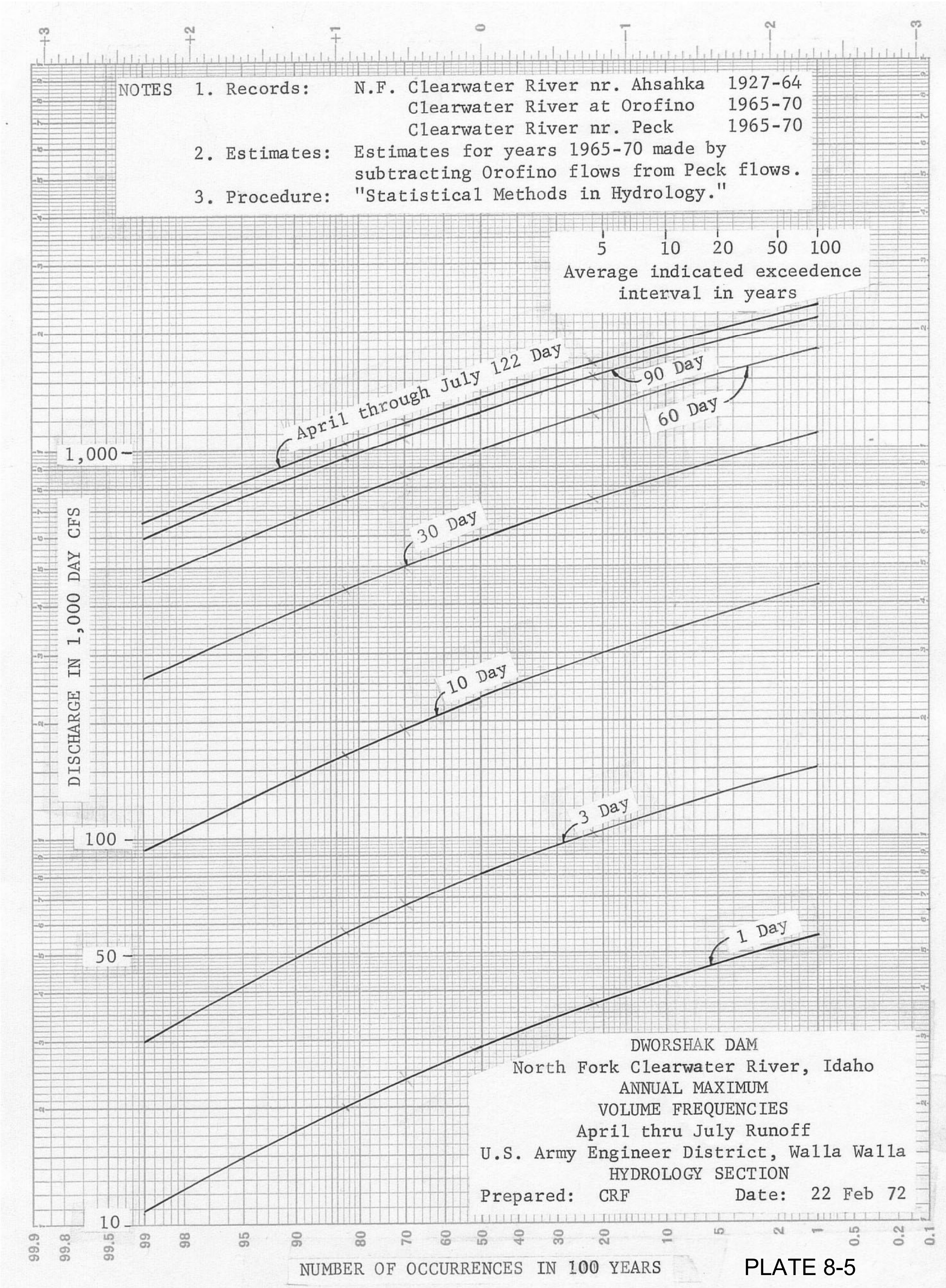
2. This is a preliminary graph subject to revision.

3. Curve 1 represents natural discharges and is based on the 1894-1975 station record adjusted for irrigation depletions and storage and extended by correlation with the 1858-1975 Columbia River at The Dalles station record. It includes an expected probability adjustment. The station and adopted skew is -0.5. Natural discharges for the 1894-1975 period of record are plotted based on their ranking within the extended record. The median plotting position method was utilized.

DWORSHAK DAM AND RESERVOIR
North Fork Clearwater River, Idaho

**ANNUAL PEAK DISCHARGE FREQUENCIES**
**Snake River At Lower Granite Dam**

U.S. Army Engineer Division, N.P.
NPDEN-WM-HES May 1978



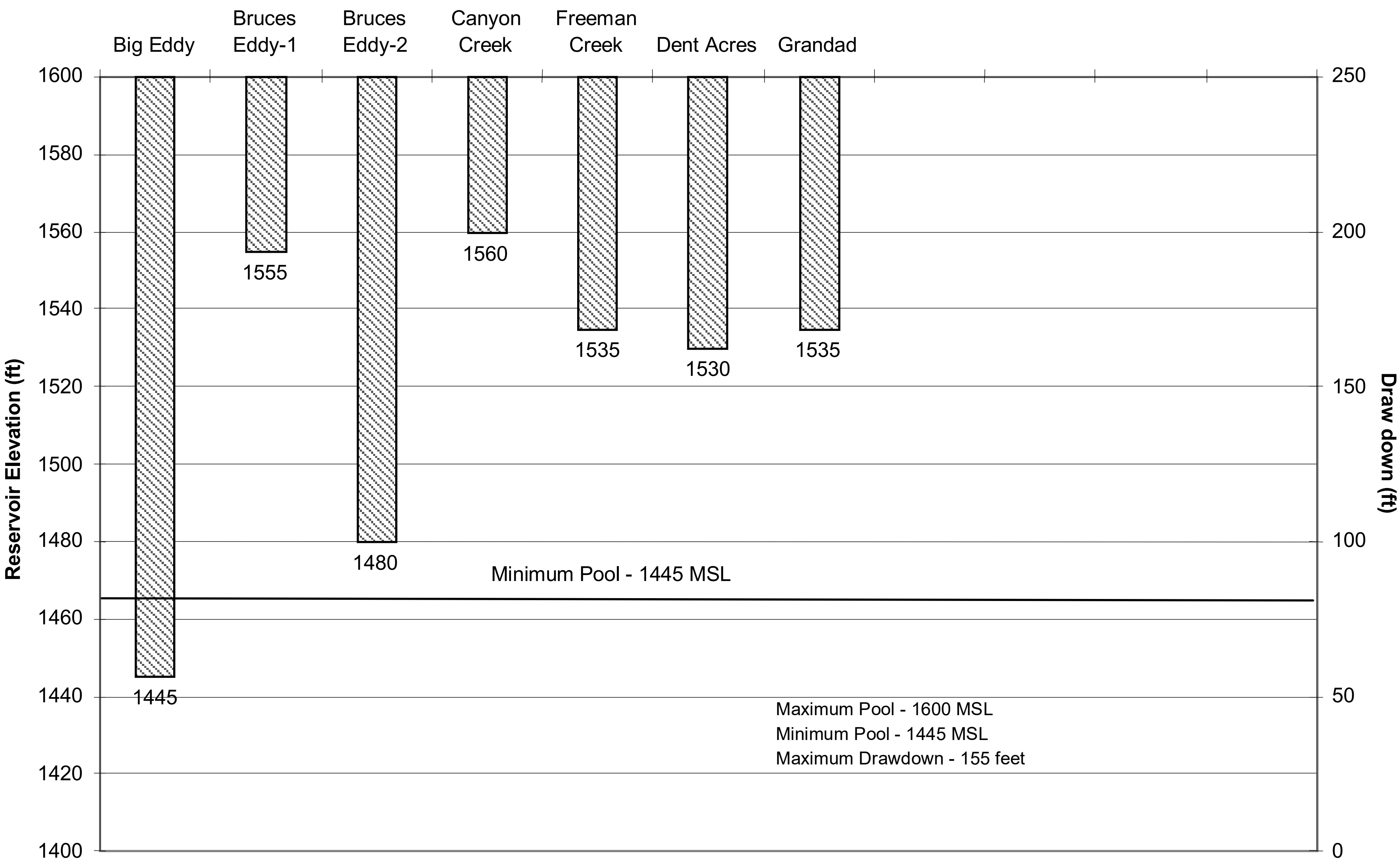
NOTES 1. Records: N.F. Clearwater River nr. Ahsahka 1927-64
Clearwater River at Orofino 1965-70
Clearwater River nr. Peck 1965-70
2. Estimates: Estimates for years 1965-70 made by subtracting Orofino flows from Peck flows.
3. Procedure: "Statistical Methods in Hydrology."
5 10 20 50 100
Average indicated exceedence interval in years
April through July 122 Day
90 Day
60 Day
30 Day
10 Day
3 Day
1 Day
DISCHARGE IN 1,000 DAY CFS
1,000
100
50
10
99.9 99.8 99.5 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1
+3 +2 +1 0 −1 −2 −3
NUMBER OF OCCURRENCES IN 100 YEARS
DWORSHAK DAM
North Fork Clearwater River, Idaho
ANNUAL MAXIMUM
VOLUME FREQUENCIES
April thru July Runoff
U.S. Army Engineer District, Walla Walla
HYDROLOGY SECTION
Prepared: CRF Date: 22 Feb 72


PLATE 8-5

# FIGURES

No.

## Figure 2-1 Boat Launch Ramps - Usable Access



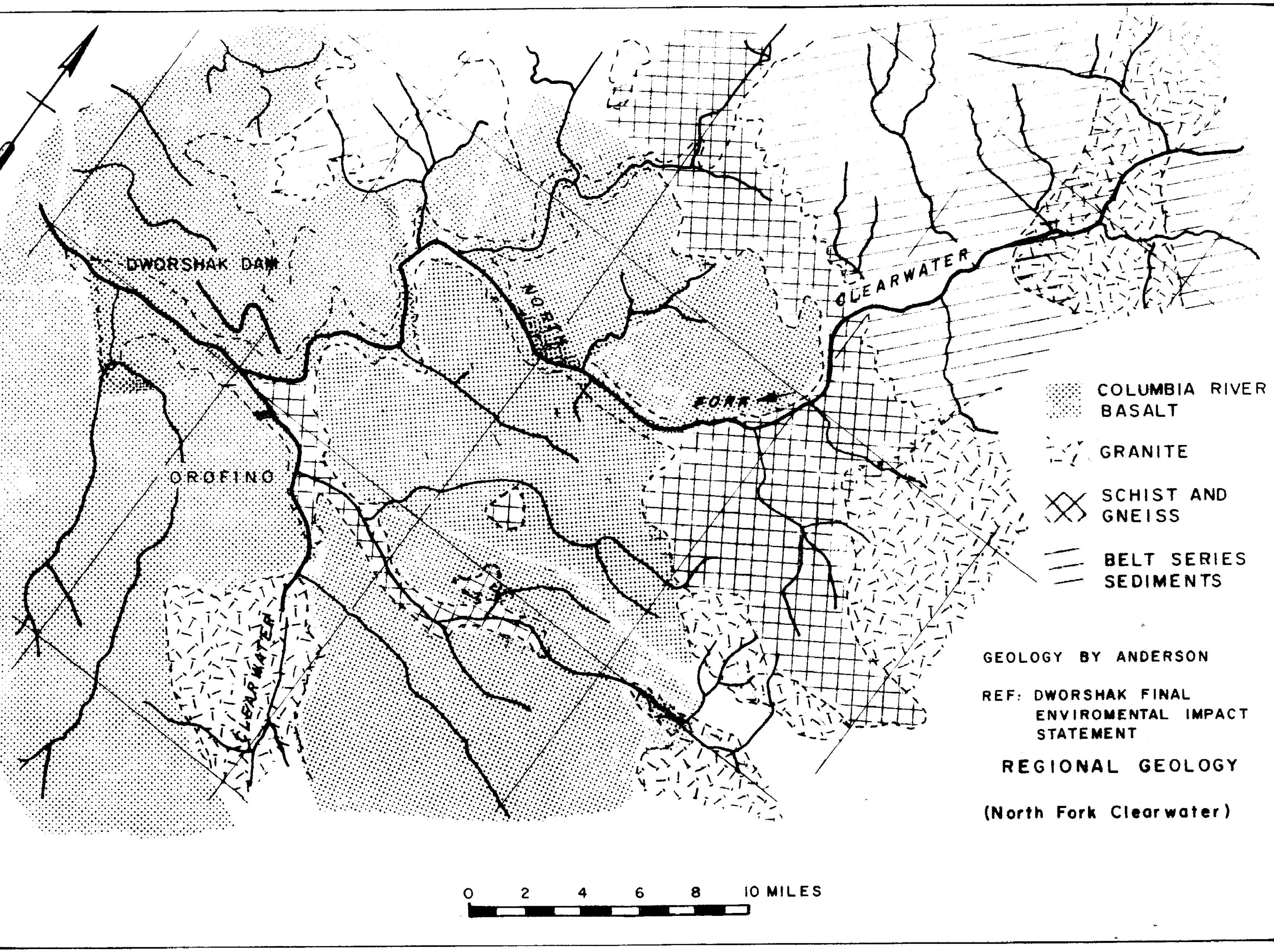

DWORSHAK DAM
OROFINO
NORTH
FORK
CLEARWATER
CLEARWATER
COLUMBIA RIVER BASALT
GRANITE
SCHIST AND GNEISS
BELT SERIES SEDIMENTS
GEOLOGY BY ANDERSON
REF: DWORSHAK FINAL ENVIROMENTAL IMPACT STATEMENT
REGIONAL GEOLOGY
(North Fork Clearwater)
0 2 4 6 8 10 MILES

FIGURE 4-1

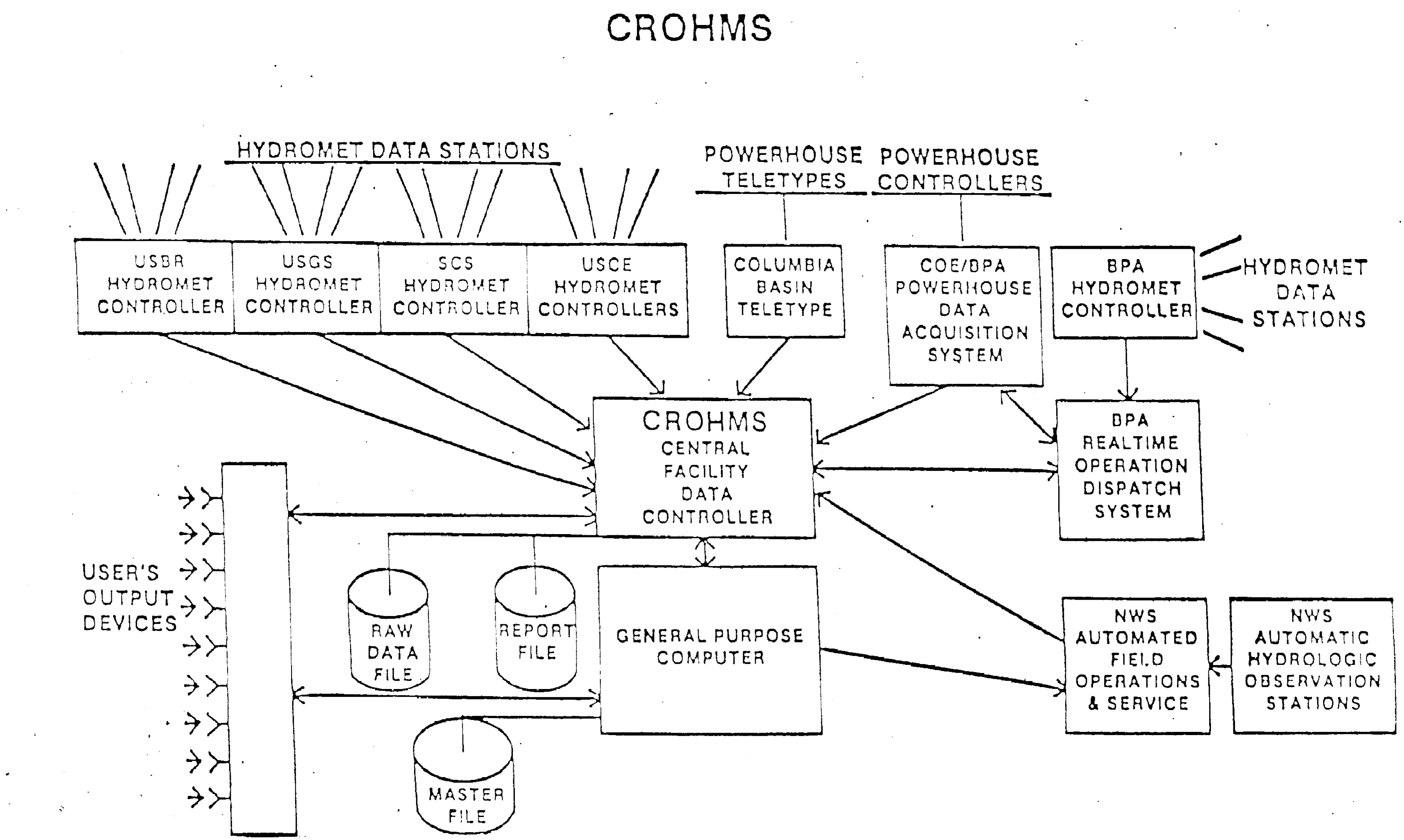



FIGURE 5-1. CROHMS Network Diagram.

# EXHIBITS

EXHIBIT 1-1

DWORSHAK DAM AND RESERVOIR
DESIGN MEMORANDUMS

| No. | | Cover Date |
|---|---|---|
| 1 | Hydrology | 15 December 1960 |
| 2 | Type and Height of Dam | |
| | Volume 1 | 20 July 1960 |
| | Volume 2 | 1 July 1959 |
| 3 | General Design Memorandum (3 Volumes) | 15 September 1961 |
| | Supplement 1, Site Selection and Type of Concrete Dam | 24 October 1962 |
| | Supplement 2, Power Plant Studies | 13 November 1964 |
| | Supplement 3, Hydrologic Reporting Network | 21 May 1971 |
| | Letter Supplement 4, Boundary Surveys and Marking | 18 November 1975 |
| | Letter Supplement 5, Deletion of Left Abutment Access Road | 26 May 1971 |
| | Letter Supplement 6, Main Dam Debris Room | 6 July 1972 |
| | Supplement 7, Dam and Powerhouse Completion | 10 December 1976 |
| 4 | Deleted | |
| 5 | Powerplant, Preliminary Design Report | December 1966 |
| | Supplement 1, Transmission Facilities and Station Service Power Supply | November 1968 |
| 5.1 | Powerhouse Architectural Design | July 1967 |
| 5.2 | Powerhouse Structural Design | January 1968 |

| No. | | Cover Date |
|---|---|---|
| 5.3 | Powerhouse Mechanical Design | October 1968 |
| 6 | Main Dam, Grouting and Drainage, and Instrumentation | 3 November 1964 |
| | Letter Supplement 1, Dam Drainage | 4 November 1980 |
| | Letter Supplement 2, Sealing Upstream Face Crack for Monolith 35 | 11 December 1980 |
| 6.1 | Main Dam Ancillary Features | 16 April 1965 |
| | Supplement 1, Penstocks, Penstock Emergency Gates, and Cathodic Protection | 19 January 1966 |
| | Supplement 2, Multi-Level Power Intake Structure | 3 October 1969 |
| 6.2 | Main Dam Gantry Crane | 17 February 1971 |
| 6.3 | Main Dam Postcooling Facilities | 13 April 1966 |
| 7 | Initial Relocations, Access, and Detour Road | 8 January 1963 |
| | Supplement 1, Relocations, Access, and Detour Road, Lower Reservoir Area | 18 August 1964 |
| | Letter Supplement 1, Freeman Creek Access Road | February 1984 |
| | Supplement 2, Right Bank Access and Detour Roads | 5 February 1965 |
| 7.1 | Deleted | |
| 7.2 | Deleted | |
| 7.3 | Powerhouse Access Road | 2 July 1969 |

| No. | | Cover Date |
|---|---|---|
| 7.4 | (Left Abutment Access Road) Cancelled; See Letter Supplement 5 to D.M. 3 | |
| 7.5 | Dent Bridge | July 1966 |
| 7.6 | Relocation of Clearwater Highway District Road | 22 November 1966 |
| 7.6 | Relocation of Clearwater Highway District Road (Continued) | |
| | Letter Supplement 1, Paving Highway District Road | 7 September 1976 |
| 7.7 | Relocation of Clearwater County Road | 20 February 1967 |
| | Letter Supplement 1, Boat Ramp, Dent Bridge Area | 2 February 1968 |
| | Letter Supplement 2, Paving County Road | (Unapproved) |
| | Letter Supplement 3, Slide Repair | |
| 7.8 | Deleted | |
| 7.9 | Deleted | |
| 8 | Real Estate, Part 1, Damsite Construction Area, Access Roads, Related Borrow and Spoil Areas, Partial Flowage, and Public-Use Areas | 31 December 1962 |
| | Letter Supplement 1, Fish Hatchery | 8 August 1966 |
| | Letter Supplement 2, Ahsahka Railroad Siding | 9 September 1967 |
| 8 | Real Estate, Part 2, Remainder of the Project, Remaining Public-Use Areas, Flowage Requirements, and Relocations | 10 December 1963 |

| No. | | Cover Date |
|---|---|---|
| 8 (cont'd) | | |
| | Letter Supplement 1, Big Game Replacement Range | 1 August 1966 |
| | Letter Supplement 2, Clearwater Highway District and Clearwater County Road Relocations | 17 March 1967 |
| 9 | Diversion Tunnel, Temporary Fish Facilities, Cofferdams | 22 April 1964 |
| | Supplement 1, Design and Cost Revisions, Temporary Fish Facilities | 14 October 1964 |
| 10A | Reservoir Preliminary Master Plan | 20 June 1966 |
| 10 | Reservoir Public Use Plan | 17 April 1970 |
| 10.1 | Recreation Facilities and Public Use Areas | 1 December 1971 |
| | Letter Supplement No. 1, Mini-Recreation Sites | 29 August 1972 |
| | Letter Supplement No. 2, Dent Orchards Day-Use Area | 29 March 1977 |
| 10.2 | Freeman Creek Recreation Development | 16 November 1978 |
| 10.3 | Group Camps 1 and 3 | 29 October 1976 |
| | Letter Supplement 1, Value Engineering Study | July 1979 |
| | Letter Supplement 2, Three Meadows Group Camp | November 1983 |
| 11 | Resident Office Facilities | 8 January 1965 |

DWORSHAK DAM AND RESERVOIR
DESIGN MEMORANDUMS
(Continued)

| No. | | Cover Date |
|---|---|---|
| 12 | Spillway and Outlets | 2 June 1965 |
| | Letter Supplement 1, Stilling Basin Repair | 13 May 1974 |
| | Letter Supplement 2, Stilling Basin and Outlet Repairs | 12 November 1974 |
| | Letter Supplement 3, Stilling Basin Wall Extension | 27 July 1979 |
| 13 | Log Handling Facilities | 5 March 1966 |
| | Letter Supplement 1, Interim Log Facilities | 20 February 1974 |
| | Letter Supplement 2, Project Log Handling Elements | 24 August 1977 |
| 14 | Permanent Fish Facilities at Dam | 3 June 1966 |
| 14.1 | Steelhead Fish Hatchery | July 1966 |
| | Supplement 1, Conversion of Rearing Facilities and Provision for Resident Fishery Mitigation | 25 November 1970 |
| | Letter Supplement 2, State Highway Drainage Repair | 24 February 1971 |
| | Letter Supplement 3, Laboratory Facilities | 30 April 1971 |
| | Letter Supplement 4, Water Treatment Facility Aerators | 17 June 1974 |
| | Letter Supplement 5, Additional Construction Requirements | 1 June 1976 |

| No. | | Cover Date |
|---|---|---|
| 14.1 | Steelhead Fish Hatchery (Continued) | |
| | Supplement 6, Building for Nursery Tanks | 27 October 1977 |
| | Letter Supplement 7, Energy Conservation Program | January 1982 |
| | Supplement 8, Reuse System I Modification for Support of Ponds and Nursery Tanks | August 1980 |
| | Supplement 9, Modification of Reuse System II | 5 August 1977 |
| | Letter Supplement 10, Modification of Filterbed Reuse System III | 6 July 1979 |
| | Letter Supplement 11, Hatchery Water Supply | |
| 15 | Plan for Development of Rocky Mountain Elk Habitat | Rev. 6 April 1978 |
| 16 | Concrete Aggregate and Concrete Properties Investigations | 17 November 1966 |
| 17 | Concrete Temperature Investigations | 22 November 1966 |
| 18 | Upper Reservoir Roads | 4 December 1969 |
| 18.1 | Grandad Creek Bridge | December 1968 |
| 19 | Reservoir Clearing | 3 December 1963 |
| | Supplement 1, Clearing Below Minimum Pool | 10 December 1969 |
| | Letter Supplement 2, Debris Gathering and Disposal | 13 June 1974 |

DWORSHAK DAM AND RESERVOIR
DESIGN MEMORANDUMS
(Continued)

| No. | | Cover Date |
|---|---|---|
| 20 | Visitor Facilities and Site Restoration | January 1972 |
| | Supplement 1, Access Features for Visitors and Operations | 15 November 1978 |
| | Letter Supplement 1, Dock Access | Deleted May 1981 |
| 20.1 | Architectural Treatment | 18 February 1966 |
| | Letter Supplement 1, Elevator on Downstream Face of Dam | 13 September 1971<br>Deleted 6 May 1974 |
| 20.2 | Damsite Visitor Viewpoint Development | 29 March 1966 |
| 20.3 | Left Abutment Accessory Features | |
| 21 | Relocation Washington Water Power Company Electrical Facilities | 30 October 1970 |
| 22 | Cost Allocation Studies | June 1975 |
| 23 | Engineering Control During Construction | 5 December 1969 |
| 24 | Reservoir Filling Plan | 12 November 1970 |
| 25 | Proposed Reservoir Sedimentation Ranges and Investigation | April 1978 |
| 26 | Master Plan (Draft) | July 1985 |

# DWORSHAK UNREGULATED INFLOW VOLUME FORECAST PROCEDURE

U.S. ARMY CORPS OF ENGINEERS
WALLA WALLA DISTRICT

The Dworshak runoff forecast precedure consists of a multiple regression equation of the following form:

$$Y = C0 + C1(Ycomb)$$

Where,

Y = Forecasted runoff volume for the period 1 April through 31 July.

Ycomb = (Yprecip + Ywc)/2) (Average of the Snow water content forecast (Ywc) plus the precipitation forecast (Yprecip).

C0, C1 = Regression Coefficients (Table 4).

* If forecast date is after 1 January, Ycomb = Ywc , do not include precipitation forecast.

## SNOW WATER CONTENT FORECAST:

Ywc = (Sum [A0 + A1(X1)])/n  (average forecast for snow courses used)

Where,

Ywc = Averaged forecasted runoff volume (Date - 31 July).

A0,A1 = Regression coefficients (Tables 1 and 2).

X1 = Snow course measured water content in inches.

n = Number of snow courses used in forecast.

## PRECIPITATION FORECAST:

$$Yprecip = B0 + B1(X2)$$

Where,

Yprecip = Forecasted Runoff Volume (Date - 31 July).

B0, B1 = Regression Coefficients (Table 3).

X2 = accumulated average monthly sums of weighted precipitation.

The following pages illustrate forecast procedures.

DWORSHAK SNOW WATER CONTENT FORECAST PROCEDURE:

| Snow course | Elevation (feet) | A0 (Table 1) | A1 (Table 2) | X1 measured water content (inches) | Forecasted runoff (in.) (YWC=A0+A1(X1) |
|---|---|---|---|---|---|
| Crater Meadows | 6,100 | | | | |
| Crooked Fork | 3,600 | | | | |
| Elk Butte | 5,550 | | | | |
| Fishlake Airstrip | 5,000 | | | | |
| Hemlock Butte | 5,500 | | | | |
| Hoodoo Basin | 6,000 | | | | |
| Hoodoo Creek | 5,900 | | | | |
| Lolo Pass | 5,240 | | | | |
| Lost Lake | 6,000 | | | | |
| Savage Pass | 6,170 | | | | |
| Shanghai Summit | 4,600 | | | | |

Total = Sum [Ywc = A0 + A1(X1)] = ____________

n = Number of snow courses used for forecast = _________

Ywc(inches) = average = Total/n = _________________(inches)

DWORSHAK PRECIPITATION FORECAST PROCEDURE:

| Precipitation Station | Station Weight | Measured Station Precipitation (inches) Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
|---|---|---|---|---|---|---|---|---|---|
| Avery R.S. | 1.63 | | | | | | | | |
| Elk River | 1.42 | | | | | | | | |
| Headquarters | 1.36 | | | | | | | | |
| Mullan | 1.39 | | | | | | | | |
| North Star Ranch | 2.36 | | | | | | | | |
| Orofino | 2.07 | | | | | | | | |
| Pierce | 1.23 | | | | | | | | |
| Powell | 1.39 | | | | | | | | |
| | Monthly weight | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.80 | 0.60 | 0.40 |

| | Elevation | Station Weight x Monthly Weight x Precipitation Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
|---|---|---|---|---|---|---|---|---|---|
| Avery R.S. | 2,390 | | | | | | | | |
| Elk River | 2,918 | | | | | | | | |
| Headquarters | 3,138 | | | | | | | | |
| Mullan | 3,319 | | | | | | | | |
| North Star Ranch | 2,800 | | | | | | | | |
| Orofino | 1,027 | | | | | | | | |
| Pierce | 3,100 | | | | | | | | |
| Powell | 3,632 | | | | | | | | |
| Weighted Monthly Sum | | | | | | | | | |
| Average Monthly Sum | | | | | | | | | |

X2 = Accumulated average monthly sums. = ______

Yprecip (inches) = B0 + B1 (X2), Refer to Table 3 for B0 & B1 values.

Yprecip (inches) = ______+______*______ = ______

DWORSHAK UNREGULATED INFLOW VOLUME INFLOW FORECAST PROCEDURE:

Forecast period ________________ through 31 July

Forecast Date ________________

Ycomb = (Ywc + Yprecip)/2   (1 January forecast)

Ycomb(inches) = (_______+_______)/2 = _______(inches)

Insert Ywc and Yprecip as computed on pages 2 and 3 of this forecast procedure.

Ycomb = Ywc(after 1 January - 31 July) = _______(inches)

Ycomb(acre-feet) = Ycomb(inches)*(130,133) = ________________ (acre-feet)

If forecast date is before 1 April:

1 April - 31 July Forecast = Y = C0 + C1(Ycomb)

Y = _______+_______*_______ = _______________ acre-feet

Use Ycomb(acre-feet) found above, C0 and C1 found in Table 4.

TABLE 1. REGRESSION EQUATION INTERCEPT A0 (inches)

| Snow Course | 1 Jan | 1 Feb | 1 Mar | 1 Apr | 1 May | 1 Jun |
|---|---|---|---|---|---|---|
| Crater Meadows | ---- | ---- | ---- | ---- | -10.1 | 2.69 |
| Crooked Fork | 6.35 | -1.01 | 1.94 | 0.02 | ---- | ---- |
| Elk Butte | ---- | ---- | 4.67 | -2.05 | -0.53 | 6.41 |
| Fish Lake | 14.65 | 9.81 | -0.21 | -1.31 | -7.65 | ---- |
| Hemlock Butte | 12.69 | 7.51 | 1.79 | -6.63 | -7.88 | 1.57 |
| Hoodoo Basin | 1.76 | -14.78 | -13.95 | -11.4 | -8.45 | -1.94 |
| Hoodoo Creek | 4.99 | -4.23 | -1.52 | -0.63 | -0.80 | -1.39 |
| Lolo Pass | 12.92 | -17.31 | -0.52 | -2.17 | -1.80 | ---- |
| Lost Lake | ---- | ---- | 5.89 | -5.06 | -3.40 | -0.44 |
| Savage Pass | 9.51 | -11.65 | -3.66 | -0.42 | -0.87 | ---- |
| Shanghai Summit | 13.03 | 4.37 | 6.67 | 4.23 | 6.40 | ---- |

TABLE 2. REGRESSION EQUATION COEFFICIENT A1

| Snow Course | 1 Jan | 1 Feb | 1 Mar | 1 Apr | 1 May | 1 Jun |
|---|---|---|---|---|---|---|
| Crater Meadows | ---- | ---- | ---- | ---- | 0.568 | 0.184 |
| Crooked Fork | 4.685 | 2.682 | 1.776 | 1.559 | ---- | ---- |
| Elk Butte | ---- | ---- | 0.584 | 0.625 | 0.517 | 0.218 |
| Fish Lake | 0.892 | 0.650 | 0.692 | 0.590 | 0.597 | ---- |
| Hemlock Butte | 0.801 | 0.566 | 0.533 | 0.562 | 0.470 | 0.207 |
| Hoodoo Basin | 1.345 | 1.110 | 0.830 | 0.606 | 0.456 | 0.286 |
| Hoodoo Creek | 1.230 | 0.901 | 0.602 | 0.454 | 0.351 | 0.281 |
| Lolo Pass | 1.487 | 1.961 | 0.914 | 0.759 | 0.604 | ---- |
| Lost Lake | ---- | ---- | 0.353 | 0.434 | 0.329 | 0.197 |
| Savage Pass | 2.007 | 1.936 | 1.202 | 0.809 | 0.631 | ---- |
| Shanghai Summit | 1.549 | 1.249 | 0.766 | 0.654 | 0.478 | ---- |

TABLE 3.

| Date | B0 | B1 |
|---|---|---|
| 1 January | 14.53 | 1.107 |
| 1 February | 11.45 | 0.737 |
| 1 March | 3.56 | 0.801 |
| 1 April | -2.40 | 0.776 |
| 1 May | -2.57 | 0.706 |
| 1 June | -5.24 | 0.733 |
| 1 July | -6.64 | 0.738 |

TABLE 4.

| Date | C0 | C1 |
|---|---|---|
| 1 January | 98200 | 0.763 |
| 1 February | -46000 | 0.854 |
| 1 March | -36500 | 0.908 |
| 1 April | 0 | 1.000 |

NOTE:
For dates other than the first of the month, values interpolated.

## EXHIBIT 7-1

## DWORSHAK RESERVOIR VARIABLE REFILL CURVE - MAY

## SAMPLE COMPUTATION THROUGH MAY 7

| Date | 95% Inflow Fcst | Mean Daily Inflow | Accum Inflow | Resid Volume Inflow | Min Outflow thru | Avail for Refill | VECC Full = 1016.4 | VRC Full = 1600.0 | Actual Elev | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| | | | | | | | | | | |
| May | KSFD | KSFD | KSFD | KSFD | KSFD | KSFD | KSFD | FT | | |
| 1 | 1,200.0 | 6.0 | 6.0 | 1,194.0 | 184.0 | 1,010.0 | 6.4 | 1,446.5 | | |
| 2 | 1,200.0 | 7.0 | 13.0 | 1,187.0 | 182.0 | 1,005.0 | 11.4 | 1,447.6 | | |
| 3 | 1,200.0 | 9.0 | 22.0 | 1,178.0 | 180.0 | 998.0 | 18.4 | 1,449.2 | | |
| 4 | 1,200.0 | 9.0 | 31.0 | 1,169.0 | 178.0 | 991.0 | 25.4 | 1,450.7 | | |
| 5 | 1,200.0 | 10.0 | 41.0 | 1,159.0 | 176.0 | 983.0 | 33.4 | 1,452.5 | | |
| 6 | 1,200.0 | 12.0 | 53.0 | 1,147.0 | 174.0 | 973.0 | 43.4 | 1,454.7 | | |
| 7 | 1,200.0 | 15.0 | 68.0 | 1,132.0 | 172.0 | 960.0 | 56.4 | 1,457.6 | | |
| 8 | 1,200.0 | | | | 170.0 | | | | | |
| 9 | 1,200.0 | | | | 168.0 | | | | | |
| 10 | 1,200.0 | | | | 166.0 | | | | | |
| 11 | 1,200.0 | | | | 164.0 | | | | | |
| 12 | 1,200.0 | | | | 162.0 | | | | | |
| 13 | 1,200.0 | | | | 160.0 | | | | | |
| 14 | 1,200.0 | | | | 158.0 | | | | | |
| 15 | 1,200.0 | | | | 156.0 | | | | | |
| 16 | 1,200.0 | | | | 154.0 | | | | | |
| 17 | 1,200.0 | | | | 152.0 | | | | | |
| 18 | 1,200.0 | | | | 150.0 | | | | | |
| 19 | 1,200.0 | | | | 148.0 | | | | | |
| 20 | 1,200.0 | | | | 146.0 | | | | | |
| 21 | 1,200.0 | | | | 144.0 | | | | | |
| 22 | 1,200.0 | | | | 142.0 | | | | | |
| 23 | 1,200.0 | | | | 140.0 | | | | | |
| 24 | 1,200.0 | | | | 138.0 | | | | | |
| 25 | 1,200.0 | | | | 136.0 | | | | | |
| 26 | 1,200.0 | | | | 134.0 | | | | | |
| 27 | 1,200.0 | | | | 132.0 | | | | | |
| 28 | 1,200.0 | | | | 130.0 | | | | | |
| 29 | 1,200.0 | | | | 128.0 | | | | | |
| 30 | 1,200.0 | | | | 126.0 | | | | | |
| 31 | 1,200.0 | | | | 124.0 | | | | | |

The following are the steps necessary to compute the elevations necessary on a daily basis to assure refill.

1. Sum mean daily inflow from the date the forecast of total inflow was made.

2. Subtract cumulative inflow from total forecast inflow through July. The result is the residual inflow forecast volume.

3. Sum the minimum required outflow through July from the current date.

4. Subtract the result of 3 from the result of 2. This gives the amount of water available for refill before July.

5. Subtract 4, the available refill, from the total reservoir storage at full pool. This gives the amount of storage that must exist on the day of computation to assure refill. Any storage over this amount may be used to serve secondary power loads.

6. The amount of storage found in 5 may then be used with the appropriate storage table to find the pool elevation.

EXHIBIT 7-1

January 10, 1994

Planning Division (1110-2-1150a)

Mr. Wesley G. Rose, O.D.
Chairman
Idaho Fish and Game Commission
201 South Lincoln
Jerome, Idaho 83338

Dear Mr. Rose:

Thank you for your letter of December 5, 1993, regarding the water control management of Dworshak Dam and how water management decisions are made.

We are and have been deeply concerned about the regulation of Dworshak Reservoir, especially during the summer months when recreation related activities are of most importance to the local communities. In the late 1980's, we placed a limit on the amount of reservoir draft that the Bonneville Power Administration could request for power to 5 feet between the time the reservoir reached its maximum height and Labor Day weekend. We believed this criteria to be a solution to most of the problems with summer pool elevation prior to 1985.

However, the Pacific Northwest Power Planning Council's Fish and Wildlife Program added significant new fish requirements since 1991 and subsequently, the National Marine Fisheries Service, in their interpretation of the Endangered Species Act, specified added requirements for listed salmon. At the present, these criteria call for significant releases of water in July and August so even if the reservoir is full by late June, there could be significant (similar to 1993) drafts to provide for flows at Lower Granite Dam. Once these drafts are made, there is little hope for the reservoir to recover for the prime summer season because the runoff is essentially over by mid-July. Thus far we have honored both initiatives, fully understanding the consequences to project uses.

Until the Biological Opinion and our Record of Decision is published in 1994, we cannot explicitly identify the expected elevations/releases of Dworshak Reservoir for 1994 or for the next 5 years for which the Biological Opinion is being written.

In response to your request for background information relative to how water management decisions are made, we are enclosing the following documents:

a. The Columbia River System

b. Historical Review of Dworshak Operation

Please contact Mr. David Reese, Chief, Hydrology Branch, at 509-522-6599 if you have any additional questions.

Sincerely,

James S. Weller
Lieutenant Colonel, Corps of Engineers
District Engineer

Enclosures

CF w/encls:
CENPD-PE-WM-RCC (Russ George)

KIM/PL-H/sg

REESE/PL-H

FITZSIMMONS/PL

LAWS/PL

TURNER/EA

BAEHRE/D-DE

WELLER/DE

IM-SM

PL-H Files

Corps of Engineers, Walla Walla District
Hydrology Branch, 7 January 1994

## Historical Review of Dworshak Operation

**A. Project Operation**. Dworshak reservoir elevation, inflow, and outflow for the period of record from water year 1972-1993 are shown on attached graphs (22 pgs). Since the initial filling of Dworshak reservoir was not completed until the summer of 1973, the 1974-1993 period would be considered to be representative of the project operation.

From 1974-1983 the typical pattern of operation followed the annual Operating Rule Curve for seasonal storage which included: (1) Winter flood control drawdown from September-December to provide at least 700 KAF by 15 December, (2) Spring flood control drawdown from January-March to maintain 700 KAF of space plus any additional space required, based on runoff volume forecasts, (3) Reservoir refill from April-July, and (4) Stable summer recreation pool from July-August.

Between 1984-1993 additional use of water from storage in Dworshak was used established for (1) Water Budget flow augmentation (15 April-15 June), (2) Summer flow augmentation (16 June-31 July), and lower Snake River temperature tests (August-September). Project operation from 1983-1993 are summarized in the following paragraphs:

(1) 1983 Operation. The spring of 1983 was the first year of implementation of the Water Budget as provided for under the Northwest Power Planning Council's Fish and Wildlife Program. The Lower Granite April-July runoff volume forecast was 25 million acre-feet (AF), which exceeded 23 million AF, so no releases above firm power and/or flood control requirements would be required from Dworshak. The actual level of flows during the 15 April through 15 June Water Budget period flows at Lower Granite generally remained above 85 kcfs and additional water from Dworshak was not required for the Water Budget. The Water Budget was not an integral part of the coordinated system plan in 1983 because power operations planning occurs one year prior to actual implementation. 1983 tested the process of implementation and revealed problems such as methods of keeping track of amount of water used for Water Budget purposes and daily or weekly implementation.

(2) **1984 Operation**. This was the second year for operation of the Water Budget but only the first in which the Water budget was first incorporated into the system power studies. The Lower Granite April - July runoff volume forecast was 21.6 million AF, which indicated that during the Water Budget period flows expected at Lower Granite would not be adequate to meet the required minimum flow level of 85 kcfs at Lower Granite. However, above normal precipitation conditions during the 1984 snowmelt season caused flows in the Snake River at Lower Granite to exceed 85 kcfs during the Water Budget period and as a result, additional water from Dworshak was not required.

(3) 1985 Operation. The Lower Granite April - July runoff volume forecast was 24.2 million AF, which indicated sufficient runoff from uncontrolled areas above Lower Granite that flow augmentation from Dworshak would probably not be necessary during the Water Budget period. Lower Granite. However, dry weather conditions, which began in December continued through April and May, coupled with cool temperatures in late April and early May resulted in low flows at Lower Granite from 20 April through 18 May. Dworshak discharge was increased from 1,000 cfs to full powerhouse capacity, 10,000 cfs, on 23 April. Even with the additional water from Dworshak the flows at Lower Granite were less than the desired minimum fish flow of 85 kcfs during the 22 April through 2 May period and again from 11-17 May. During the Water Budget period Dworshak provided 366 KAF of water for flow augmentation at Lower Granite.

(4) 1986 Operation. The Lower Granite April - July runoff volume forecast was 19.6 million AF, which indicated that during the Water Budget period flows expected at Lower Granite would not be adequate to meet the required minimum flow level of 85 kcfs at Lower Granite. However, a wet April and early May followed by unseasonably hot weather in late May and June resulted in sufficient flows at Lower Granite that the 400 KAF allocated from storage in Dworshak was not required for flow augmentation.

(5) 1987 Operation. The Lower Granite April - July runoff volume forecast was 13.3 million AF, which indicated that during the Water Budget period flows expected at Lower Granite would not be adequate to meet the required minimum flow level of 85 kcfs at Lower Granite. Therefore, approximately 300 KAF of storage in Dworshak and 150 KAF in Brownlee was made available for the Water Budget. Even with Water Budget releases of up to 25 kcfs from Dworshak and up to 26 kcfs from Brownlee, the flows at Lower Granite only exceeded 85 kcfs for 9 days during the Water Budget period. Where only limited storage is available in Dworshak and Brownlee for the Water Budget, it is not possible for these reservoirs to meet the 85 kcfs minimum desired fish flow in low runoff years. Dworshak provided 381.4 KAF of water from storage for the Water Budget.

(6) 1988 Operation. The Lower Granite April - July runoff volume forecast was 13.3 million AF, which indicated that during the Water Budget period flows expected at Lower Granite would not be adequate to meet the required minimum flow level of 85 kcfs at Lower Granite. Therefore, approximately 300 KAF of storage in Dworshak and 150 KAF in Brownlee was allotted for the Water Budget. Even with Water Budget releases of up to 25 kcfs from Dworshak and up to 25 kcfs from Brownlee, the flows at Lower Granite did not exceeded 85 kcfs and were over 80 kcfs on only 4 days during the Water Budget period. Where only limited storage is available in Dworshak and Brownlee for the Water Budget, it is not possible for these reservoirs to meet the 85 kcfs minimum desired fish flow in low runoff years. Dworshak provided 301.3 KAF of water from storage for the Water Budget.

(7) 1989 Operation. The Lower Granite April - July runoff volume forecast was 21.3 million AF (24 percent of average) Therefore, approximately 240 KAF of storage in Dworshak and 150 KAF in Brownlee was allotted for the Water Budget to maintain minimum flow level of 85 kcfs at Lower Granite. Flows at Lower Granite remained above 85 kcfs until 26 April. On 25 April the Fish Passage Center requested that 100,000 cfs be maintained at Lower Granite. Even with Water Budget releases of up to 20 kcfs from Dworshak and up to 31 kcfs from Brownlee, the flows at Lower Granite did not exceeded 100 kcfs until 7 May. The Water Budget discharges from Dworshak and Brownlee were reduced during the seasonal peaking period to maintain the requested 100 kcfs at Lower Granite. Then after the seasonal peak, Water Budget releases from Dworshak were again requested for the 15-20 May period: 10 kcfs for three days and 5 kcfs for two days. This used up the allotted of 240 KAF and also an additional 42 KAF.

(8) 1990 Operation.

(a) Water Budget Regulation. The 1 April forecast of spring runoff for the Snake River at Lower Granite Dam was 14.8 million AF (65 percent of average). Based on that forecast, RCC committed to providing 308 KAF of shapeable storage from Dworshak for the 1990 Water Budget. Water Budget releases of up to 25,000 cfs were made from Dworshak during the period 7-15 May at the request of the Fish Passage Center in Portland and the reservoir was drawndown 14 feet from elevation 1586 to elevation 1572. Dworshak inflows during the 7-15 May Water Budget period averaged 11,000 cfs. The portion of the releases during the 7-15 May period that was credited to Water Budget totaled 307.6 KAF.

Following heavier than normal late spring precipitation, additional releases from Dworshak were needed for flood control in late May and June. As a result of increasing Dworshak outflows from 1,000 cfs to 9,500 cfs coupled with a special operation of Lower Granite to increase nighttime outflows and some increase in natural flows, the smolt index counts at Lower Granite Dam rose from 29,065 on 24 May (Lower Granite inflow 55,700 cfs) to 430,970 on 27 May (Lower Granite inflow 68,000 cfs). This special operation from 24-28 May provided an additional 61 KAF of water from Dworshak for flow augmentation above the 307.6 KAF that was credited to the Water Budget.

Regulated releases from Dworshak eventually reached a maximum of 17,100 cfs on 7 June and flows on the Clearwater River at Spalding reached a maximum of 70,000 cfs on 29 May. The peak regulated Lower Granite inflow reached a maximum of 119,200 cfs on 20 May during the 15 April - 15 June Water Budget period.

Dworshak reservoir refilled to elevation 1595 on 8 June, elevation 1599 on 1 July, and elevation 1600 on 18 July. Actual runoff for the 1 April - 31 July period totaled 2.8 million AF, or about 99 percent of average.

(b) Lower Snake River Temperature Regulation Test. In early September, the Fish Passage Center noted that unusually warm water temperatures in the 72 degree to 78 degree Fahrenheit range and low flows in the Lower Snake and Lower Columbia appeared to be hindering the upstream migration of the adults. RCC responded by increasing Dworshak releases from 1,000 cfs to 9,500 cfs (full powerplant capacity) in conjunction with the normal fall drawdown of Dworshak Reservoir. The Dworshak selector gates were also adjusted to lower the water temperature of the releases to 47 degrees Fahrenheit for about two weeks (7-19 September). After that the water temperatures of the releases were raised to the normal 53 degrees. During this special operation, the water temperature at Lower Granite Dam only dropped about 3 degrees, from 70 degrees to 67 degrees Fahrenheit, and no change in water temperature attributable to the special operation was noted downstream.

(9) 1991 Operation.

(a) **Water Budget and Flow Augmentation**. The 1 April forecast of spring runoff for the Snake River at Lower Granite Dam was 13.9 million AF (61 percent of average). Based on that forecast, RCC committed to providing shapeable water from Dworshak for the 1991 Water Budget. From 26 April to 5 May, following a request from the Fish Passage Center in Portland, Dworshak released 25,000 cfs discharged 400 KAF of water representing the Grand Coulee flood control shift (Supplemental Water Budget). On 5 May the outflow was reduced to near 11,500 cfs and releases from the standard Water Budget storage began. Through the end of May, at the request of the Fish Passage Center, 600 KAF of Water Budget water was release with outflows varying between 2,000 cfs and 20,200 cfs to augment Lower Granite inflows for juvenile fish migration. Dworshak reservoir was drafted to elevation 1,556.8 during the Water Budget releases, and then filled to elevation 1,581.7 by 31 May.

During the first week of June , an additional 100 KAF of water, above the previous 400 KAF credited to the Water Budget, was made available to the Fish Passage Center for Water Budget flow augmentation. At the request of the Fish Passage Center, Dworshak was filled to elevation 1599.6 ft., 0.4 ft. from full pool of 1,600 ft., on 24 June so it would be passing inflow when the sub yearling chinook salmon outmigration began in late June. Also from 9-13 July, Dworshak released 9,500 cfs and drafted 2 ft. to augment flows for the sub yearling chinook salmon.

The peak inflow for the year was 28,100 cfs on 19 May while outflow at the time was 9,000 cfs. The April - July observed runoff was 2.7 Million AF (96% of average) as compared to the forecasted April-July runoff of 2.3 million AF (82 % of average). Dworshak reservoir was refilled and maintained between 1,599 and 1600 ft. through 15 August.

(b) Lower Snake River Temperature Control. From 16 - 21 August, Dworshak released 9,400 cfs and drafted 5 ft., to evaluate the influence of cold water releases from Dworshak on lower Snake River water temperatures.

Following this release, Dworshak passed inflow through Labor Day weekend and then increased to full load and drafted throughout September for power and lower Snake River Temperature control. Dworshak reservoir reached elevation 1,565.1 by 30 September, 35 ft. from full pool.

(10) 1992 Operation.

(a) Water Budget. The 1 April forecast of spring runoff for the Snake River at Lower Granite Dam was 9.9 million AF (46 percent of average). Based on that forecast, RCC committed to providing 900 KAF of water from Dworshak for the 1992 Water Budget and Flow Augmentation. From 22-26 April, following a request from the Fish Passage Center in Portland, Dworshak released 12,000 cfs of Water Budget. Another 12,000 cfs was released from 1-6 May followed by 6 days of 9,500 cfs , when outflow was reduced to 2,000 cfs for two days because of damage to the spillway gate seals. As a result, the reservoir refilled to full pool of 1,600 ft. on 13 May and at the request of the Fish Passage Center, outflows were increased to 24,000 cfs for 3 days, which drafted the reservoir 6.5 ft. to elevation 1,593.4 ft.. From 21 May - 4 June Dworshak released 9,500-11,800 cfs for Water Budget. in order to flush hatchery steelhead through Lower Granite reservoir, Dworshak released 25,000 cfs during the 5-10 June period, which used up the remaining balance of the 900 KAF of Water Budget storage. On 10 June Dworshak reservoir was at elevation 1,575.0 ft., 25 ft. from full pool. Outflow was reduced to 1,000 cfs for the remainder of June and the reservoir refilled slightly to elevation 1578.9 ft.

(b) Flow Augmentation and Temperature Control. From 5-20 July, Dworshak provided outflows of 10,000 cfs and 20,000 cfs, from an additional 270 KAF of Flow Augmentation Water, at the request of the Fish Passage Center for sub yearling chinook salmon outmigration. This operation lowered the reservoir elevation 1563.5 ft., 37 ft. from full pool and out flow water temperature was lowered from 54 degrees to 45 degrees Fahrenheit. Dworshak outflow was reduced to 1,200 cfs until early August when outflows were increased from 1,200 cfs to 2,500 cfs to provide the additional water needed to maintain the lower Snake River projects within their 1% peak efficiency limits. By Labor Day weekend Dworshak reservoir was at elevation 1559.0, 41 ft. from full pool. From 10-20 September, Dworshak outflow was maintained at 11,200 cfs in order to release an additional 200 KAF from storage for power and lower Snake River temperature control, then outflows were reduced to 1,200 cfs. Dworshak reservoir reached elevation 1,545.8 by 30 September, 54 ft. from full pool.

The peak inflow for the year was 14,600 cfs on 30 April while outflow at the time was 2,900 cfs. The April - July observed runoff was 1.3 million AF (49% of average).

(11) **1993 Operation**. The 1 April forecast of spring runoff for the Snake River at Lower Granite Dam was 15.9 million AF (73 percent of average). Based on that forecast, RCC committed to providing 1000 KAF of water from

Corps of Engineers, Walla Walla District
Hydrology Branch, 7 January 1994

Dworshak for the 1993 Water Budget and Flow Augmentation. The 1993 Coordinated Plan of Operation for the fish passage season started out to be similar to 1992 operation, however, "Target Flows" at Lower Granite Dam on the lower Snake River of (1) 85,000 cfs for 1 May-30 June and (2) 50,000 cfs 1-31 July as required by the biological opinion issued by the National Marine Fisheries services on 26 may 1993 were included in the Corps' Record of Decision dated 18 June 1993.

During the 15 April - 30 June period releases from Dworshak were adjusted as needed for local flood control at Lewiston, Idaho and enhanced juvenile fish outmigration flows at Lower Granite Dam. From 1-31 July releases from Dworshak were regulated for "Target Flow" at Lower Granite Dam. Releases above 1,200 cfs from Dworshak provided 1,904 KAF for juvenile fish outmigration during the 15 April-31 July period.

Dworshak's reservoir midnight elevation on 15 April was 1,582.78 ft. On 1 May Dworshak reservoir began to refill from elevation 1582.71 ft. to elevation 1595.13 ft. on 15 May and then gradually refilled to a maximum elevation of 1599.96 on 3 July. During July the Dworshak outflow was adjusted to provide a portion of the target flow (50 KCFS) at Lower Granite Dam and releases above 1,200 cfs provided 648 KAF. From 1 - 13 August releases from Dworshak above 1,200 cfs provided an additional 393 KAF of water from storage to encourage fall chinook juvenile salmon to migrate down the Clearwater River. This operation was requested by the National Marine Fisheries Services. Dworshak was drafted to elevation 1540.15, 60 ft. from full pool, by 13 August. Dworshak's release was reduced to 1,200 cfs to conserve the water supply after 14 August. Dworshak releases for fish and average monthly flows for Dworshak releases and Lower Granite regulated inflow for April through August are summarized as follows:

**DWORSHAK RELEASE FOR FISH TARGET FLOWS**

| TIME PERIOD | RELEASE (KAF) |
|---|---|
| 15-30 April | 249 |
| MAY | 707 |
| JUNE | 300 |
| JULY | 648 |
| AUGUST | 393 |
| TOTAL | 2,297 |

**AVERAGE OBSERVED FLOWS IN CUBIC FEET PER SECOND (CFS)**

| | APRIL | MAY | JUNE | JULY | AUGUST |
|---|---|---|---|---|---|
| DWORSHAK RELEASE | 5,433 | 12,697 | 6,247 | 11,739 | 7,594 |
| LOWER GRANITE INFLOW | 66,600 | 131,665 | 98,520 | 50,126 | 33,377 |

MEMORANDUM OF UNDERSTANDING

BETWEEN THE CLEARWATER FISH HATCHERY, DWORSHAK NATIONAL FISH HATCHERY AND THE U.S. ARMY CORPS OF ENGINEERS DWORSHAK PROJECT FOR THE OPERATION AND ENTRANCE REQUIREMENTS FOR THE HATCHERY WATER SUPPLY SYSTEM.

Definition

Clearwater Fish Hatchery will be referred to as "Clearwater FH" or "CFH". Dworshak National Fish Hatchery will be referred to as the "Dworshak Hatchery" or "DNFH". The Dworshak project of the U.S. Army Corps of Engineers will be referred to as the "Dworshak project" or "project".

Purpose

This Memorandum of Understanding (MOU) describes the roles, responsibilities and safety requirements of the signatory parties for the operation, maintenance and emergency procedures related to the water supply line from Dworshak Reservoir to the Clearwater Fish Hatchery and Dworshak National Fish Hatchery. All parties agree to the responsibilities and procedures outlined in this MOU.

## PART I
## PROJECT DESCRIPTION

### I. Authorization and Location

The Clearwater Fish Hatchery Water Supply System is part of the Lower Snake River Compensation Plan (LSRCP) Program. The LSRCP was established by the Water Resources Development Act of 1976 (Public Law 94-587) to compensate for losses caused by the lower Snake River dams. The Clearwater Fish Hatchery water supply system delivers water from Dworshak Reservoir to the CFH and DNFH. The hatcheries are located near the confluence of the North Fork and the main stem of the Clearwater rivers near Ahsahka, Idaho.

### II. Brief Description of Project

The CFH water supply system consists of primary and secondary pipelines. The primary pipeline is equipped with a selective withdraw intake screen that allows water at selectable tempatures to be withdrawn when available. A floating platform allows the intake screen to be adjusted from 5 to 50 feet below the water surface. The secondary pipeline has a fixed low level intake that provides water at a temperature that is consistently near $40^0$F. Both pipelines are routed through Dworshak Dam and then down the face of the dam along the spillway training wall. The pipelines are then buried and follow the left bank of the North Fork Clearwater River to the distribution structure. The distribution structure is the transition between the incoming high pressure piping and outgoing low pressure piping. The distribution structure provides stilling wells for energy dissipation valves and distributes flow between the two fish hatcheries. Two lines from the distribution structure supply the DNFH with supplemental water. The distribution structure also provides a connection to the secondary pipeline for a potential future municipal and industrial (M&I) hookup for the City of Orofino.

## III. Construction History

The Clearwater Fish Hatchery Water Supply System was constructed under one contract let by the U.S. Army corps of Engineers. A copy of the construction report is on file at the Walla Walla District Corps of Engineers library in Walla Walla, Washington. The construction contract number, contractor, construction start date, and beneficial occupancy date are shown below:

| | |
|---|---|
| Project Title: | Clearwater Fish Hatchery Water Supply |
| Contract No.: | DACW687-90-C-0030 |
| Contractor: | Harcon Inc. and S.A. Gonzales Construction, Inc.<br>A Joint Venture<br>P.O. Box 2661<br>Pocatello, Idaho 83201 |
| Construction Start Date: | 28 August 1990 |
| Beneficial Occupancy Date: | 15 April 1992 |

# PART II
# METHOD OF OPERATION
# CLEARWATER FISH HATCHERY PIPELINE

## I. PRIMARY INTAKE STRUCTURE

Adjustments to the level of the primary intake screen will be determined by locating the seasonal thermocline in the reservoir of 56 to 58$^0$F water temperature. The screen will be raised or lowered to this thermocline. These adjustments will be done by CFH staff.

The primary intake is located inside the log boom security area on the face of Dworshak Dam. Prior to entrance of this security area a 24 hour minimum notice is to be given to the operator at the Dworshak Dam. On the day of entry into the security area, prior to entrance, Clearwater FH staff will notify the on duty operator at Dworshak Dam. After the adjustments or cleaning has been performed on the primary intake screen and the boat has left the security area Dworshak Dam operator will be notified they have left the area.

The intake was modified under the following contracts.

| Contract Number | Project | Contractor | Start | Date |
|---|---|---|---|---|
| DACW68-95-C-0011 | Clearwater Hatchery Emergency Isolation Valve | Knight Construction & Supply Company | 12/94 | 5/30/95 |
| DACW68-97-C-0017 | Clearwater Hatchery Water Supply Modifications | Advanced American Diving Service, Inc. | 3/97 | 9/30/97 |

The CFH manager will schedule a diver to inspect the primary intake screen when determined to be necessary. (The screen was designed so that it would not clog but our experience shows that the algae in the reservoir will completely plug the primary intake screen).

## II. PIPELINES FROM INTAKE TO CLEARWATER FISH HATCHERY

Routine inspections and maintenance of the pipelines will be the responsibility of the CFH. This approach has resulted from design review meetings conducted by the COE.

A. Maintenance

All maintenance of valves and pipeline from the intake to the distribution structure will be the responsibility of CFH.

## III. DISTRIBUTION STRUCTURE

Any adjustments to the ported sleeve valves on the primary and secondary pipelines will be accomplished by the manager or CFH staff. Each supply line is equipped with two ported sleeve valves. Never at any time will more than one ported sleeve valve be operated unless it is during the switch over process from one valve to another. The manager of CFH will notify the manager of DNFH of any adjustments or maintenance work which may impact distribution to DNFH.

## IV. DISTRIBUTION TO DWORSHAK NFH

The supply valves on the secondary and primary lines from distribution structure to the DNFH will remain at preadjusted levels. The amount of flow will be controlled by the DNFH manager or his staff. Prior to any adjustments, requiring more or less water from either pipeline, notification will be given to the CFH manager. This is to protect from damage to the distribution structure and pipelines resulting from either hatchery calling for more water than available and causing cavitation in the supply pipelines.

A. Maintenance

All routine maintenance of valves and pipeline from the distribution structure to DNFH will be the responsibility of DNFH. The COE will assist with non-routine maintenance, if required.

## V. DISTRIBUTION TO CLEARWATER FH

All adjustments for water flowing from the distribution structure to CFH will have prior approval from CFH manager or a designated representative and will be accomplished by the CFH staff under the managers direction.

# PART III

# OPERATION AND MAINTENANCE

## I. GENERAL

A. Scope

This section describes the equipment and routine operation and maintenance procedures for the water supply system. It also describes procedures for various emergency situations. The value of this manual is dependent upon how it is used. For this reason, additional reference data and revised procedures and parameters should be inserted into the manual as dictated by changing conditions and operator experience with this particular facility.

B. Responsibility

The operation and maintenance of the Clearwater Fish Hatchery Water Supply System from Dworshak Dam to the distribution structure, including the intake screens and energy dissipation valves, is the responsibility of the CFH personnel. The CFH personnel are also responsible for the system from the distribution structure to the CFH. The DNFH personnel, with COE assistance, when required, are responsible for the system from the distribution structure to DNFH. The Dworshak Dam operator shall be notified when problems arise with the water supply system, and specifically during emergency situations.

C. Dworshak Project Entrance Requirement

Hatchery personnel shall abide by the Dworshak Project entrance requirement and safe clearance procedure while working in the secure project area. The secure project area includes the forebay protected intake area; the main dam and powerhouse; and the south abutment, hillside, and stilling basin wall.

## II. CLEARWATER HATCHERY WATER SUPPLY

A. Annual Valve Exercise

This exercise will occur after steelhead are completely transported and released from DNFH and CFH in the spring of the year. Coordination and scheduling of exercises will be the responsibility of CFH Manager. CFH will provide six personnel, DNFH a maximum of 2 personnel and electric operator wrench.
1) All rearing areas will be converted to secondary pipeline water only.
2) Pipeline shutdown will start at CFH and DNFH on primary pipeline and proceed upstream to valves inside the dam. Once emergency closure valves are exercised, energizing of the pipeline will begin at emergency closure valves and proceed downstream to both hatcheries.
3) Both hatcheries will then convert to primary pipeline water only and proceed with shutdown of secondary pipeline at each hatchery and proceed upstream to emergency shutdown valve. When exercise is complete, energizing of pipeline will begin at emergency valve and proceed downstream to both hatcheries. Annual exercise is now completed and both pipelines are back in operation.

# PART IV
# INTAKE FACILITIES

## I. GENERAL

A. General Description

The primary intake consists of a tee-screen suspended on a cable from a floating platform. The cable is attached to a winch that allows the depth of the intake screen to be adjusted. The screen is attached to a 48-inch polyethylene pipe. The polyethylene pipe connects to a 24-inch steel pipe at the face of the dam. The secondary intake consists of a drum screen mounted on the face of the dam at elevation 1361.5 ms/l. The screen is connected to a 14-inch steel pipe. The 24-inch-diameter and 14-inch-diameter steel pipes pass through the upstream face of the dam and into the maintenance gallery in monolith 14. Inside the maintenance gallery, intake valves are installed to serve as emergency shutoff valves and pressure gauges are installed to measure the pressure differential on the intake screens.

B. Primary Intake Screen

(1) Description

The primary intake screen is a 7.5-foot-diameter by 23-foot-long Johnson tee-screen. The screen is suspended from a floating platform that is anchored to the upstream face of the dam (see Sheet 57.1 of the contract drawing). Access to the floating platform is by use of a boat stored at the CFH. The primary intake screen can be adjusted from 5 to 50 feet below the water surface using the winch on the floating platform. The water surface can vary between a maximum pool level of 1,605 msl and minimum pool level of 1,455 msl. The proper depth to provide the desired temperature is determined by taking temperature measurements from the platform with a portable, hand-held temperature gauge.

(2) Operation and Maintenance

The intake screen is required to have a minimum submergence of 4 feet. A physical restraint is attached to the screen to prevent it from inadvertently being raised to less than 4 feet of submergence. The primary pipeline intake valve (V-1) must be closed before raising the primary screen out of the water for any maintenance procedures. Raising the screen out of the water prior to closing V-1 could cause failure of the pipeline. CAUTION! Follow the procedure described under <u>Intake Value</u> for closing V-1. To avoid potential freezing problems at the water surface, the primary screen should be lowered to at least 20 feet below the water surface each fall when the temperature is approximately uniform in the top 20 feet of the reservoir, which is typically from about October to March. The wedge wire design of the screen is nonclogging and somewhat self-cleaning; therefore, additional means of cleaning were not considered necessary during the original design. However, experience to date indicates that some cleaning may be required. The screen has air backflushing connections so that backflushing equipment can be added in the future if necessary. The pressure gauge should be checked every two weeks and the screen should be inspected by a diver, if the differential pressure is rising and approaching 60 inches, or at least twice a year to determine if cleaning or other maintenance is required. See next Section <u>Pressure Gauge.</u>

(3) Pressure Gauge

An ILT Barton differential pressure gauge is installed inside the maintenance gallery to measure the pressure differential across the primary intake screen. The pressure gauge is calibrated in inches of water and has a range between 0 and 60 inches. The maximum pressure differential allowed is 60 inches. Caution! Allowing more than 60 inches pressure differential could cause damage to the intake pipe and screen.

(4) Emergency Procedures

If the head differential across the primary screen exceeds 60 inches, perform the following procedures:

1. Contact CFH manager.
2. Contact DNFH manager.
3. Contact Dworshak Dam operator.
4. Throttle back the operating primary energy dissipation valve (V-9 or V-10) while monitoring the intake pressure differential to ensure that the pressure differential reduces to less than 60 inches. This will require personnel stationed at both locations with two-way radios to communicate.
5. Determine and correct the problem. Large pressure differentials could be caused by a plugged intake screen or pipeline flows greater than design capacity.

C. Secondary Intake Screen

(1) Description

The secondary intake screen is a 6.5 foot-diameter by 7.5 foot-long Johnson drum screen. The screen is wedge wire type having inwardly enlarging openings. The secondary screen is not adjustable and is mounted at elevation 1361.5/msl.

(2) Operation and Maintenance

The wedge wire design of the screen is nonclogging and somewhat self-cleaning. Therefore, additional means of cleaning were not considered necessary during the original design. However, experience to date indicates that some cleaning may be required. The screen has air backflushing connections so that backflushing equipment can be added in the future, if necessary. The pressure gauge should be checked every two weeks and the screen should be inspected by a diver, if the differential pressure is rising and approaching 60 inches. See Section Pressure Gauge.

# PART V

## ENTRANCE REQUIREMENTS AND SAFE CLEARANCE PROCEDURE FOR NORMAL OPERATION AND MAINTENANCE AND EMERGENCY CONDITIONS FOR THE CLEARWATER FH

## I. WATER SUPPLY SYSTEM

### A. Purpose

The purpose of this section is to provide an understanding of the entrance requirements, Safe Clearance Procedure, and project personnel interaction with CFH and DNFH personnel during normal O&M and emergency conditions within the secure area of Dworshak Project. The secure project area includes the forebay protected intake area, the main dam and powerhouse, south abutment dam face, hillside, and stilling basin wall.

### B. Conditions

(1) General

Activity requiring either CFH or DNFH personnel to enter Dworshak Project secure area will be coordinated with the powerhouse control room operator prior to entry into the secure area. Work requiring access to the floating platform in the intake area will require the requesting and issuance of a safe clearance on spillway machinery (safe clearance on regulating outlet machinery is not required unless diving operations are necessary). A clearance will be issued to the shift operator and then an identical clearance will be issued to an authorized hatchery person who has been trained in the Dworshak Project Hazardous Energy Control Program. A notice of intent will be provided to the control room operator a minimum of the day prior to issuing the clearances. Hatchery personnel will verify the safe clearances have been placed on the machinery before accessing the platform. Hatchery personnel that have been working in the secure area will immediately communicate to the shift operator the completion of their work and confirmation of exiting the secure area. They will then coordinate the release of their safe clearance.

(2) Normal operation and maintenance:

Scheduled inspections and adjustments of equipment within the secure area will be made entirely by hatchery personnel. Results of the inspections will be communicated to the Dworshak Operations and Maintenance Manager.

(3) Emergency Situation:

The shift operator will not normally be available to assist in operations outside the control room such as closing the intake valves, etc.. Hatchery personnel will immediately notify the shift operator of the emergency condition and describe any potential effect on the dam or powerhouse. If the emergency requires a boat to go into the protected intake forebay area, a safe clearance on the spillway must still be requested and implemented before entering the area. If hatchery personnel are required to go to the pipe penetration area they must notify the shift operator just prior to their entrance and immediately after their exit. The COE shift operator will contact supervisory personnel who will direct or make further communication as required. Under an acute emergency condition, COE personnel would be made available to assist hatchery personnel.

## PART VI
## RESPONSIBILITIES

### I. Corps of Engineers

A. To report to the CFH and DNFH managers any problems or suspected problems.
B. To provide to CFH personnel two project entrance keys.
C. To inform CFH personnel (and provide copy) of safe clearance procedures.
D. To provide available help as allowable during an acute emergency.
E. To provide an adequate access to the 1385 gallery and the 1360 pipe penetration gallery. To maintain lighting in these areas and reliable power to the control valves.

### II. Clearwater Fish Hatchery

A. Hatchery personnel will inform the shift operator before entering the project secure areas and renotify when leaving.
B. The hatchery will provide Dworshak Project a copy of their inspection reports.
C. The hatchery personnel will abide by the Dworshak Project Hazardous Energy Control Program while working in the secure project area.

D. Hatchery personnel will secure Dworshak Project access keys and immediately report if lost or stolen. They will also ensure Dworshak Project security by keeping all doors, used for their access, secure.

E. The hatchery will inform DNFH manager of any problems which could impact flow to DNFH.

## III. Dworshak National Fish Hatchery

A. Hatchery personnel will coordinate any flow adjustments which may impact CFH with the CFH manager.

B. Hatchery will provide available help to CFH manager when requested in emergency, maintenance or water flow adjustments.

HATCHERY MANAGERS

Jerry McGehee 10/21/98
Date
Manager, Clearwater FH
Idaho Department of Fish and Game

Bill Miller 10/21/98
Date
Manager, Dworshak NFH
U.S. Fish and Wildlife Service

U.S. ARMY CORPS OF ENGINEERS

Gregory A. Parker 11/2/98
Date
Operations & Maintenance Manager
Dworshak Project

Charles R. Krahenbuhl 11/4/98
Date
Operations Manager
Eastern Operating Projects
Dworshak Project

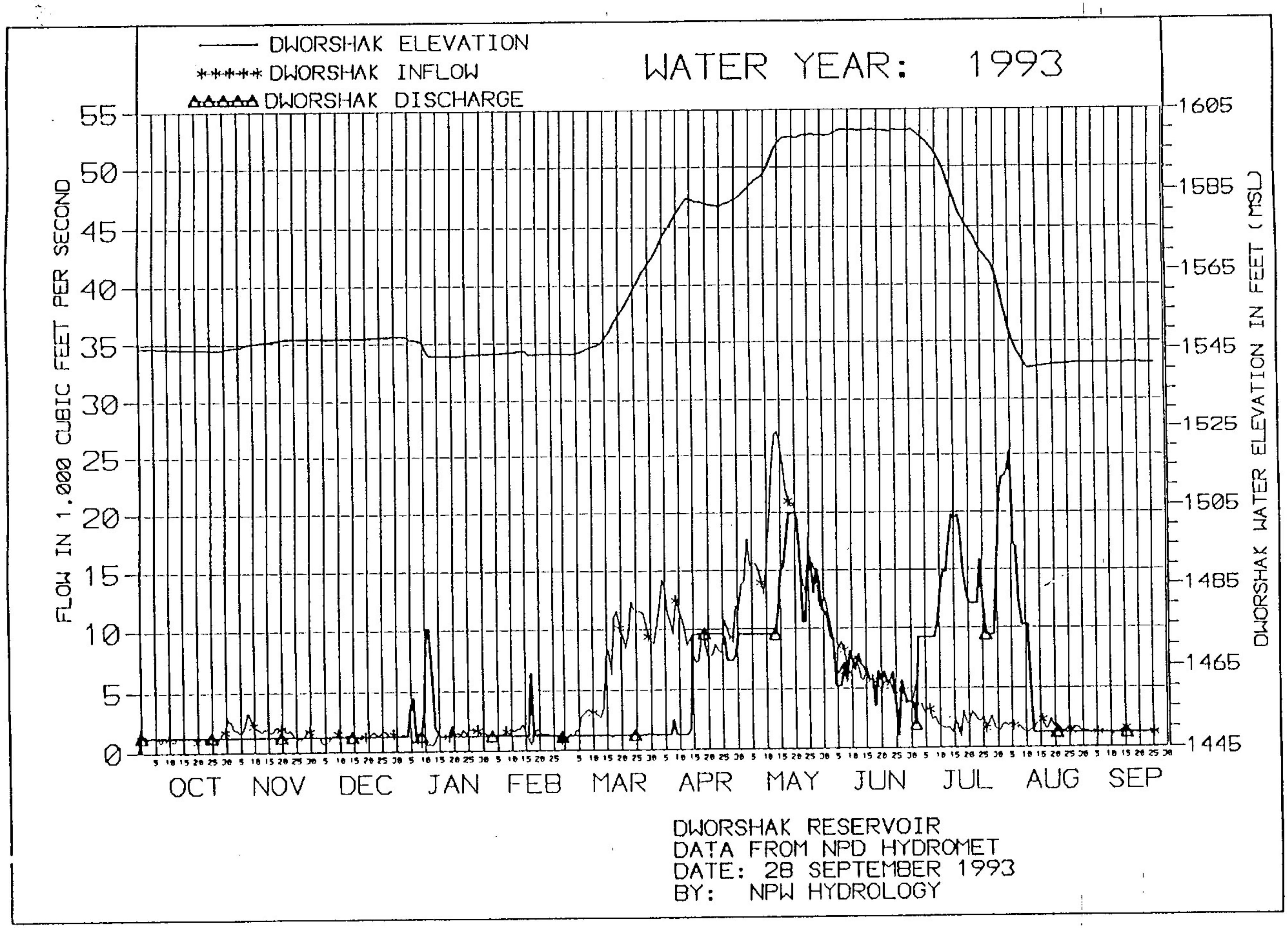
The peak inflow for the year was 27,100 cfs on 15 May while outflow at the time was 11,200 cfs. The April - July observed runoff was 2.2 million AF (81% of average).

**B.** Water Budget Operation Summary. The use of Dworshak storage for Lower Granite Water Budget evolved as a result of PL 96-501, Pacific Northwest Electric Power Planning and Conservation Act (Dec. 1980), which contains provisions to protect, mitigate, and enhance conditions for fish and wildlife on the Columbia River and Tributaries. In November 1982, the Northwest Power Planning Council developed a comprehensive Columbia River Basin Fish and Wildlife program, which was amended in 1984 and 1987. The most significant part of the program established a "Water Budget" approach which recommended a total Water Budget of 20 kcfs-months (1.19 million AF) at Lower Granite Dam for flows in excess of firm power flows from April 15 to June 15. Dworshak's participation in the Water Budget operation at Lower Granite is summarized as follows:

Dworshak Operation For Water Budget

| Year | Lower Granite 1 April Runoff Forecast (KAF) | Amount Available (KAF) | 15 April - 15 June Dworshak Total Releases (KAF) |
|---|---|---|---|
| 1983 | 25.0 | 0 | 584.4 |
| 1984 | 21.6 | 197.4 | 1,134.7 |
| 1985 | 24.2 | 0 | 786.3 |
| 1986 | 19.6 | 413.8 | 831.0 |
| 1987 | 13.3 | 308.0 | 671.0 |
| 1988 | 13.3 | 308.0 | 435.0 |
| 1989 | 21.3 | 240.0 | 734.0 |
| 1990 | 14.8 | 308.0 | 1,153.0 |
| 1991 | 13.9 | 1,106.0 1/ | 1,235.7 |
| 1992 | 9.9 | 900.0 | 1,144.5 |
| 1993 | 15.9 | 1,000.0 | 1,289.1 |

NOTE: 1/ Includes 900KAF of Columbia River system flood control shifted to Grand Coulee and 100 KAF of Supplemental Water provided in the first week of June based on June runoff forecast.



DWORSHAK ELEVATION
DWORSHAK INFLOW
DWORSHAK DISCHARGE
WATER YEAR: 1993
FLOW IN 1,000 CUBIC FEET PER SECOND
DWORSHAK WATER ELEVATION IN FEET (MSL)
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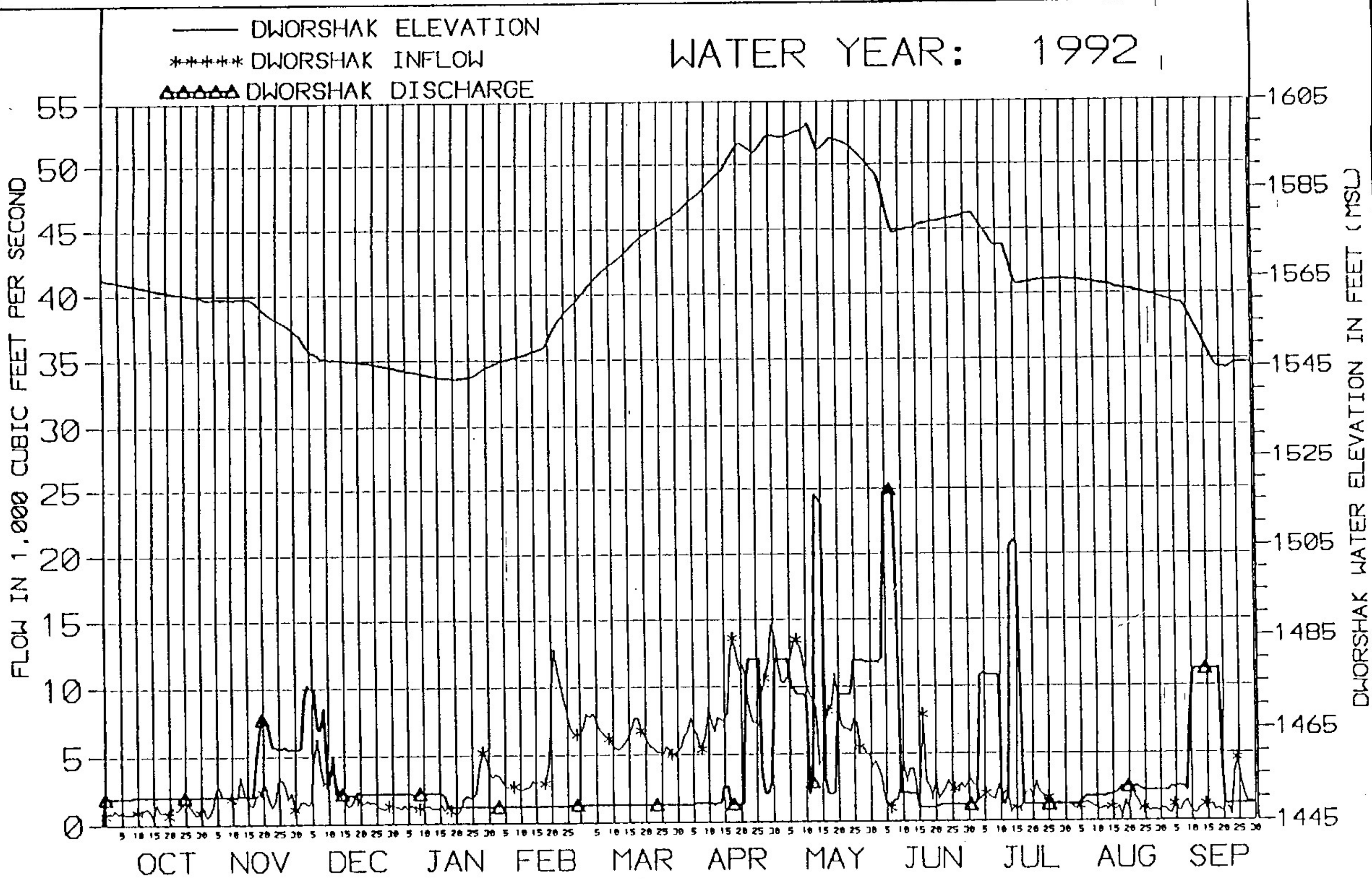


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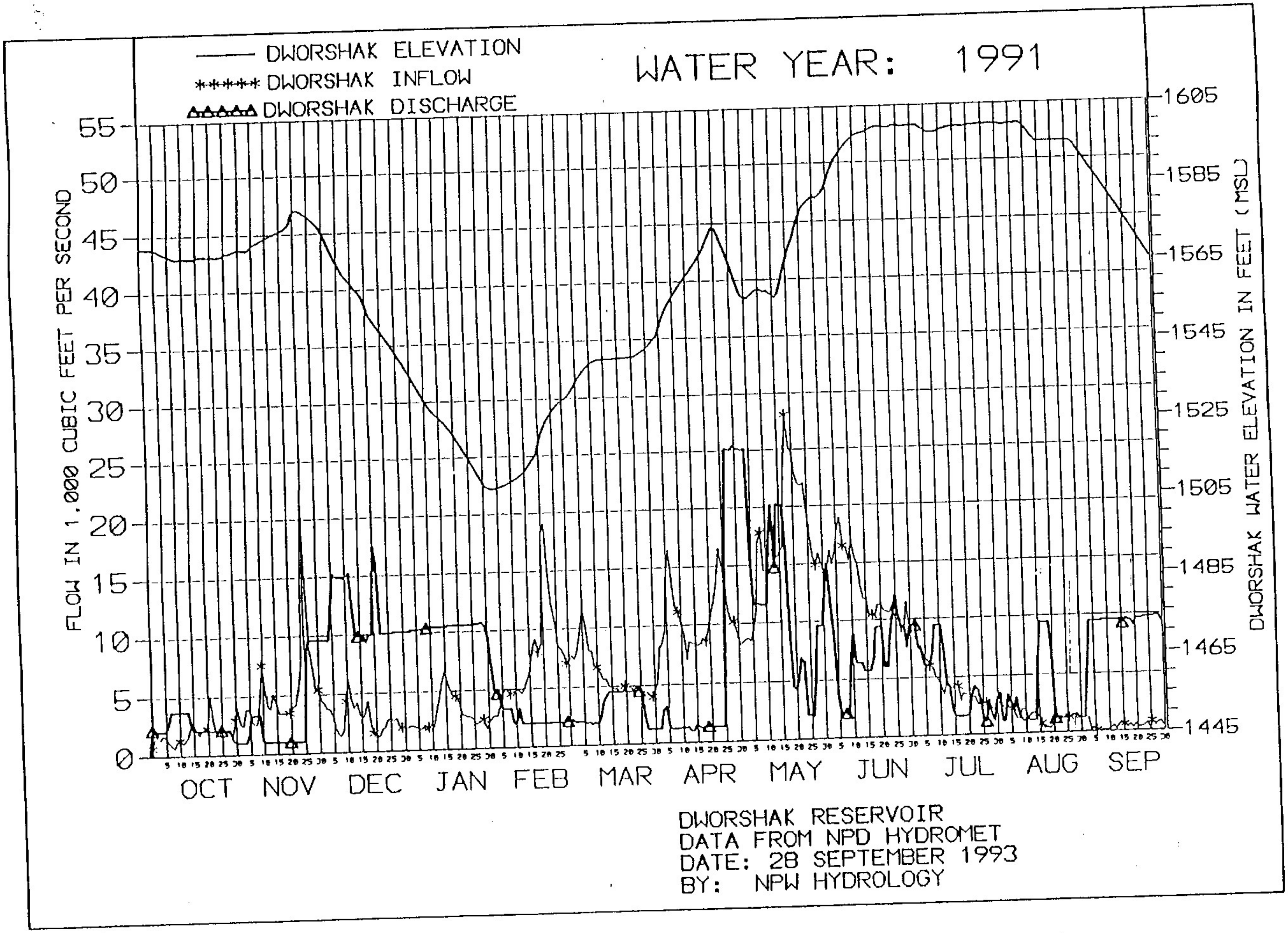

DWORSHAK ELEVATION
DWORSHAK INFLOW
DWORSHAK DISCHARGE
WATER YEAR: 1991
FLOW IN 1,000 CUBIC FEET PER SECOND
DWORSHAK WATER ELEVATION IN FEET (MSL)
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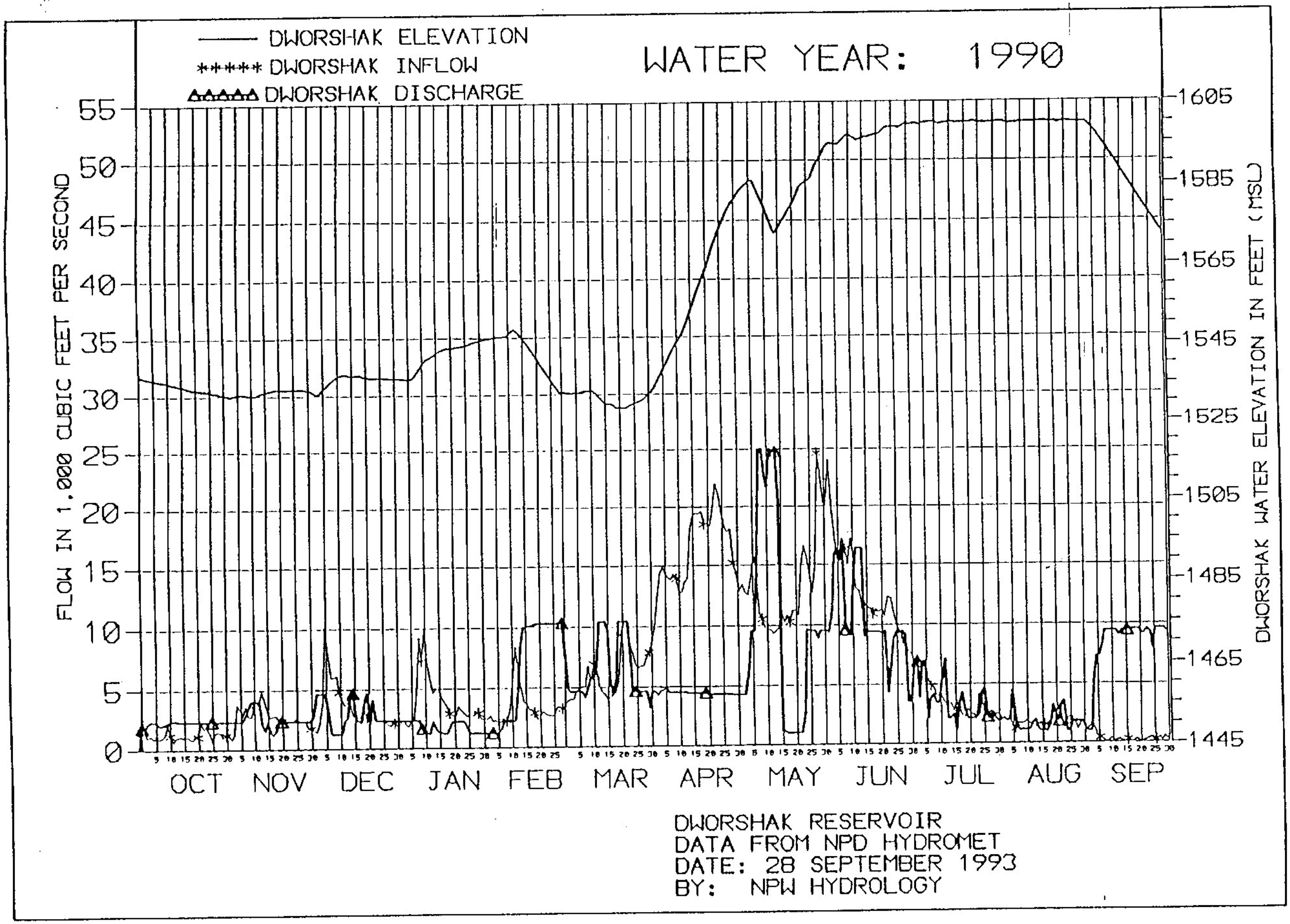

DWORSHAK ELEVATION
DWORSHAK INFLOW
DWORSHAK DISCHARGE
WATER YEAR: 1990
FLOW IN 1,000 CUBIC FEET PER SECOND
DWORSHAK WATER ELEVATION IN FEET (MSL)
0 5 10 15 20 25 30 35 40 45 50 55
1445 1465 1485 1505 1525 1545 1565 1585 1605
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
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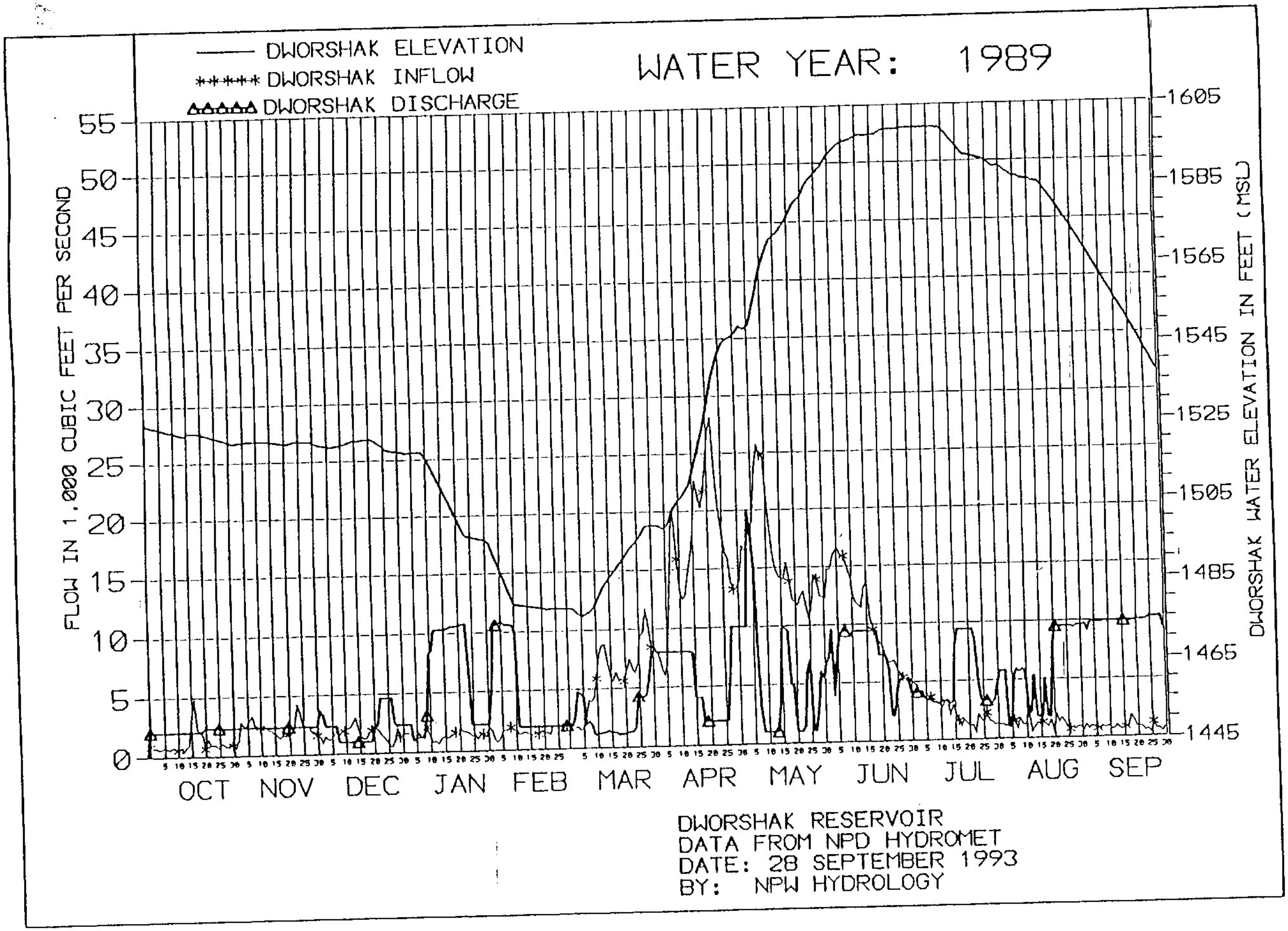

DWORSHAK ELEVATION
DWORSHAK INFLOW
DWORSHAK DISCHARGE
WATER YEAR: 1989
FLOW IN 1,000 CUBIC FEET PER SECOND
DWORSHAK WATER ELEVATION IN FEET (MSL)
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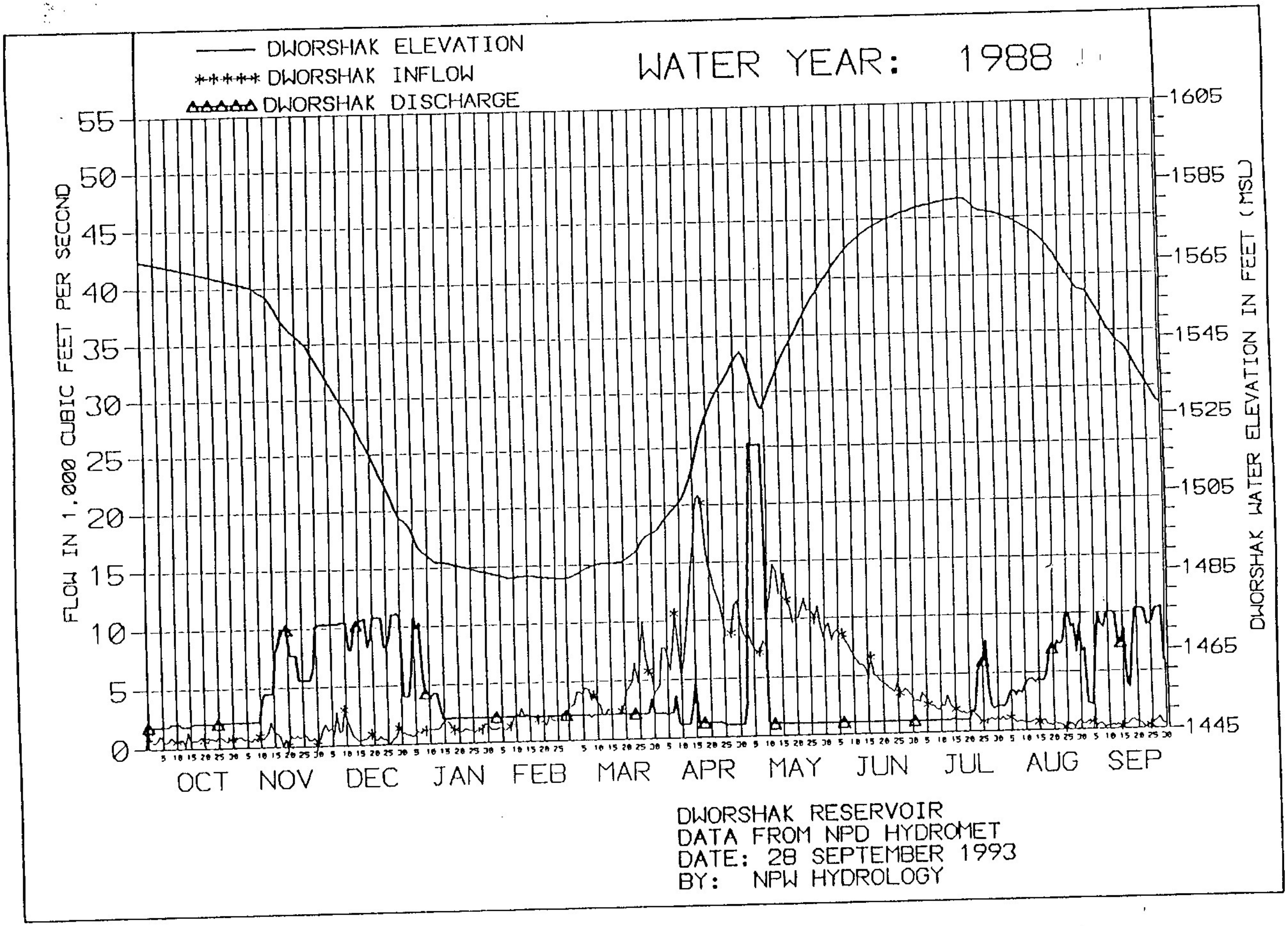

DWORSHAK ELEVATION
DWORSHAK INFLOW
DWORSHAK DISCHARGE
WATER YEAR: 1988
FLOW IN 1,000 CUBIC FEET PER SECOND
DWORSHAK WATER ELEVATION IN FEET (MSL)
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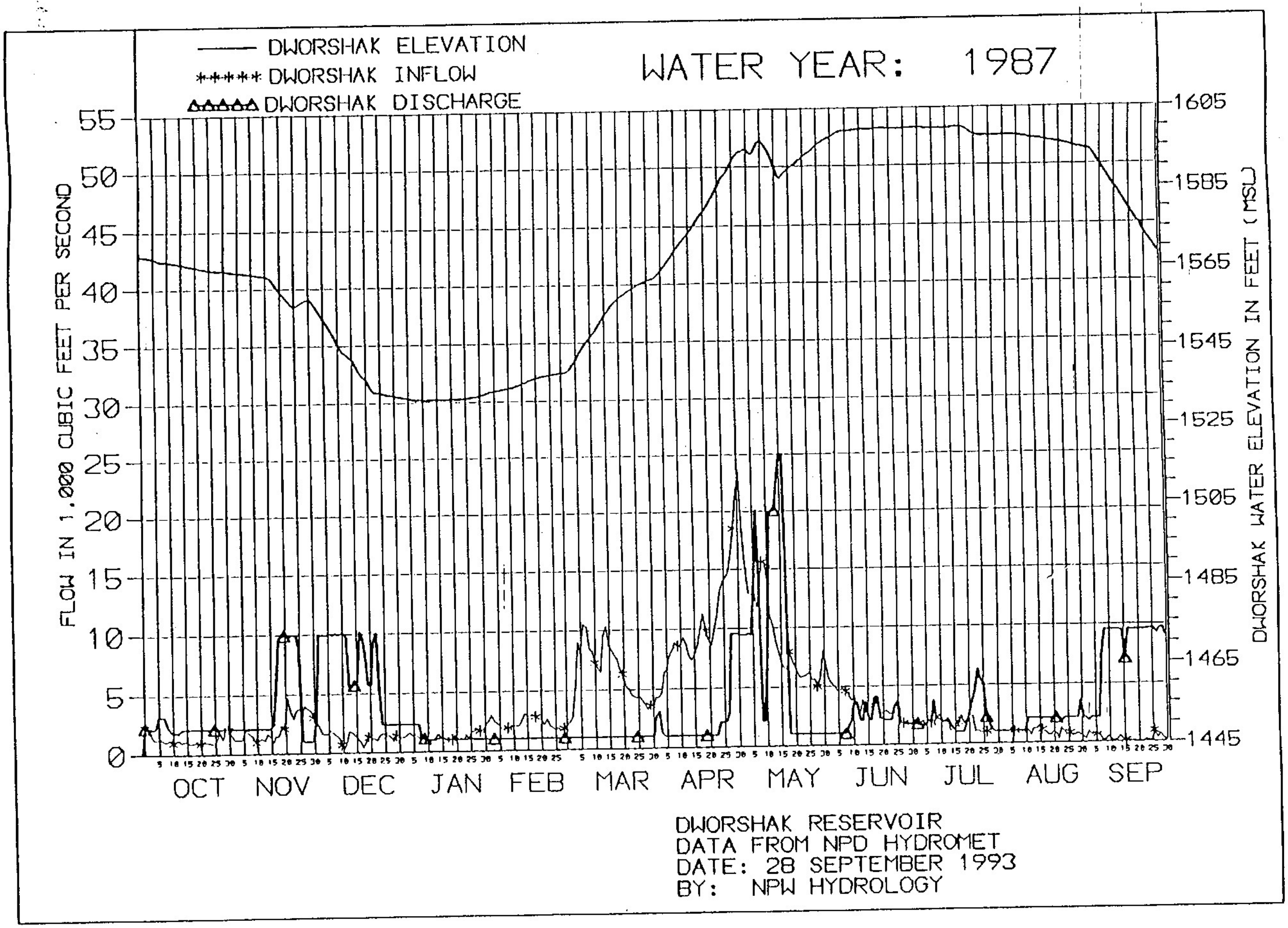

DWORSHAK ELEVATION
DWORSHAK INFLOW
DWORSHAK DISCHARGE
WATER YEAR: 1987
FLOW IN 1,000 CUBIC FEET PER SECOND
DWORSHAK WATER ELEVATION IN FEET (MSL)
0
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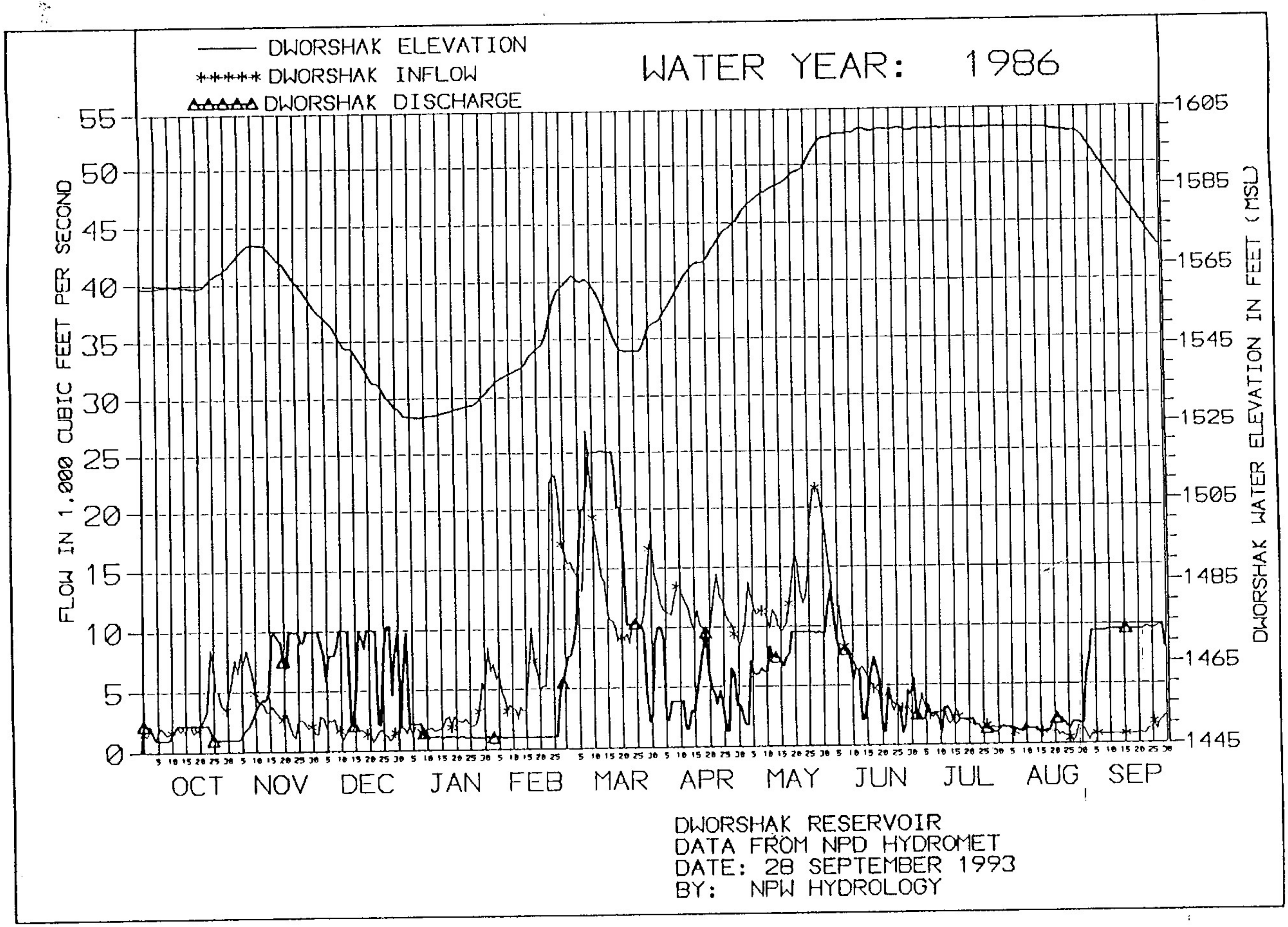

DWORSHAK ELEVATION
DWORSHAK INFLOW
DWORSHAK DISCHARGE
WATER YEAR: 1986
FLOW IN 1,000 CUBIC FEET PER SECOND
DWORSHAK WATER ELEVATION IN FEET (MSL)
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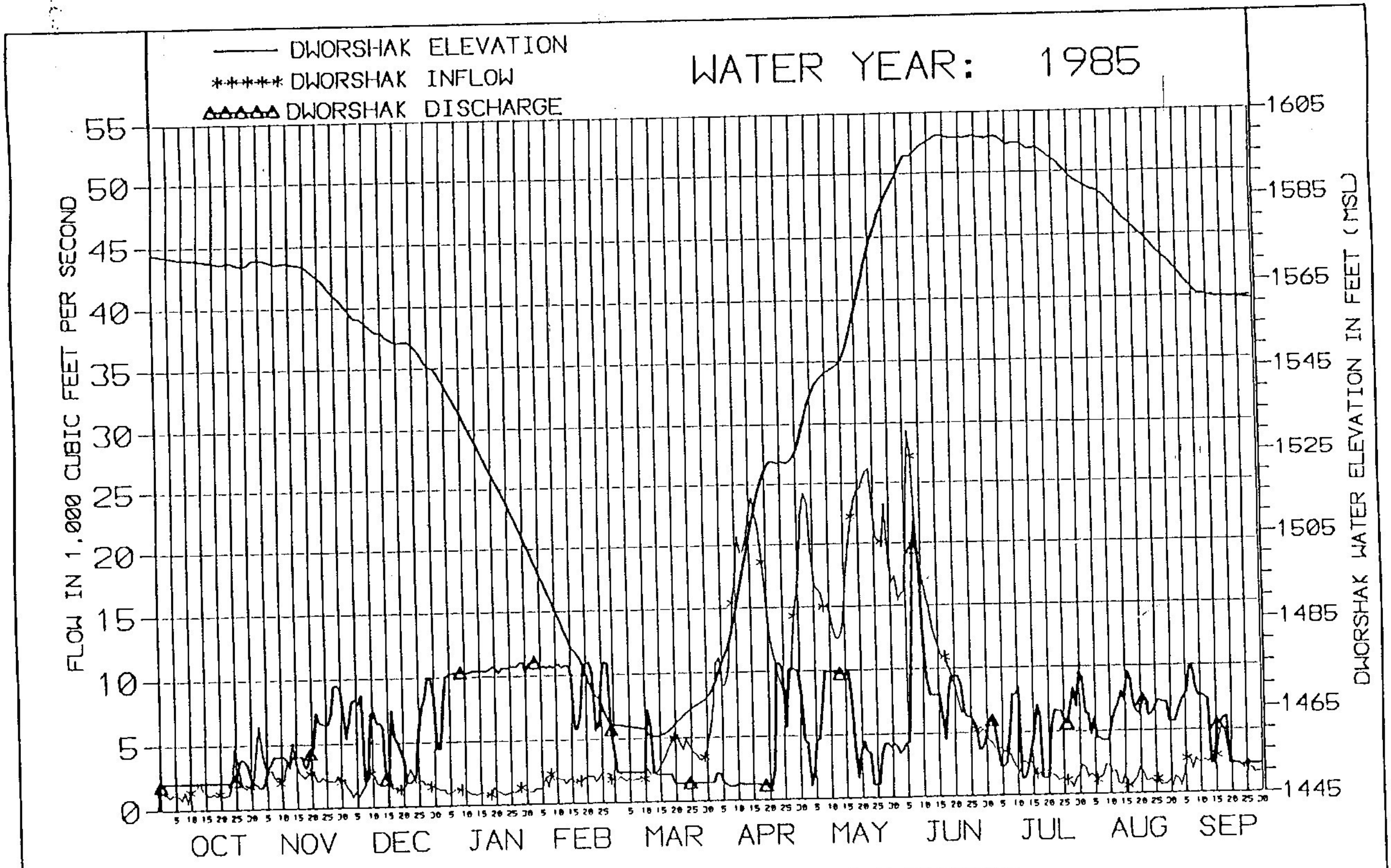


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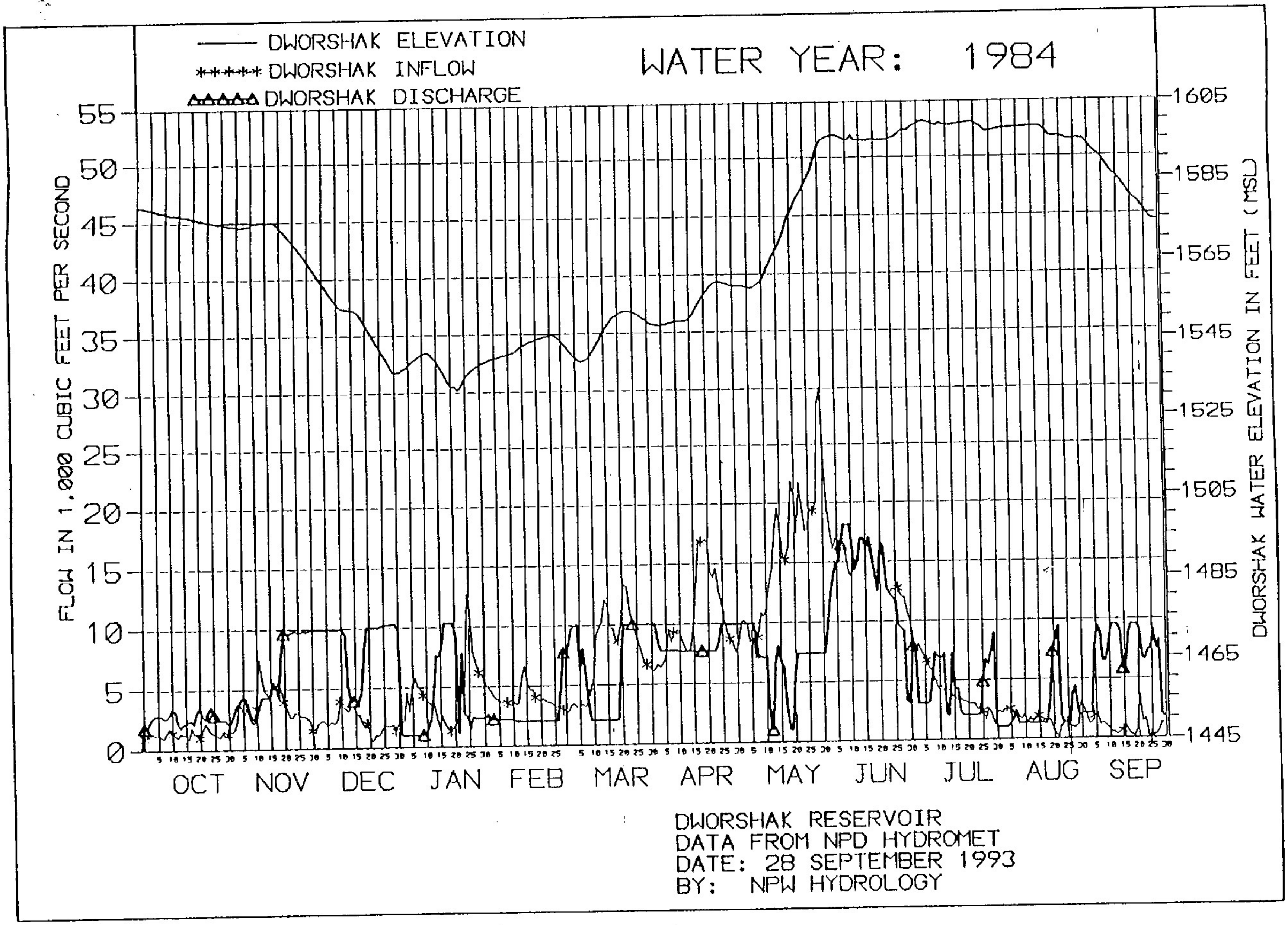

DWORSHAK ELEVATION
DWORSHAK INFLOW
DWORSHAK DISCHARGE
WATER YEAR: 1984
FLOW IN 1,000 CUBIC FEET PER SECOND
DWORSHAK WATER ELEVATION IN FEET (MSL)
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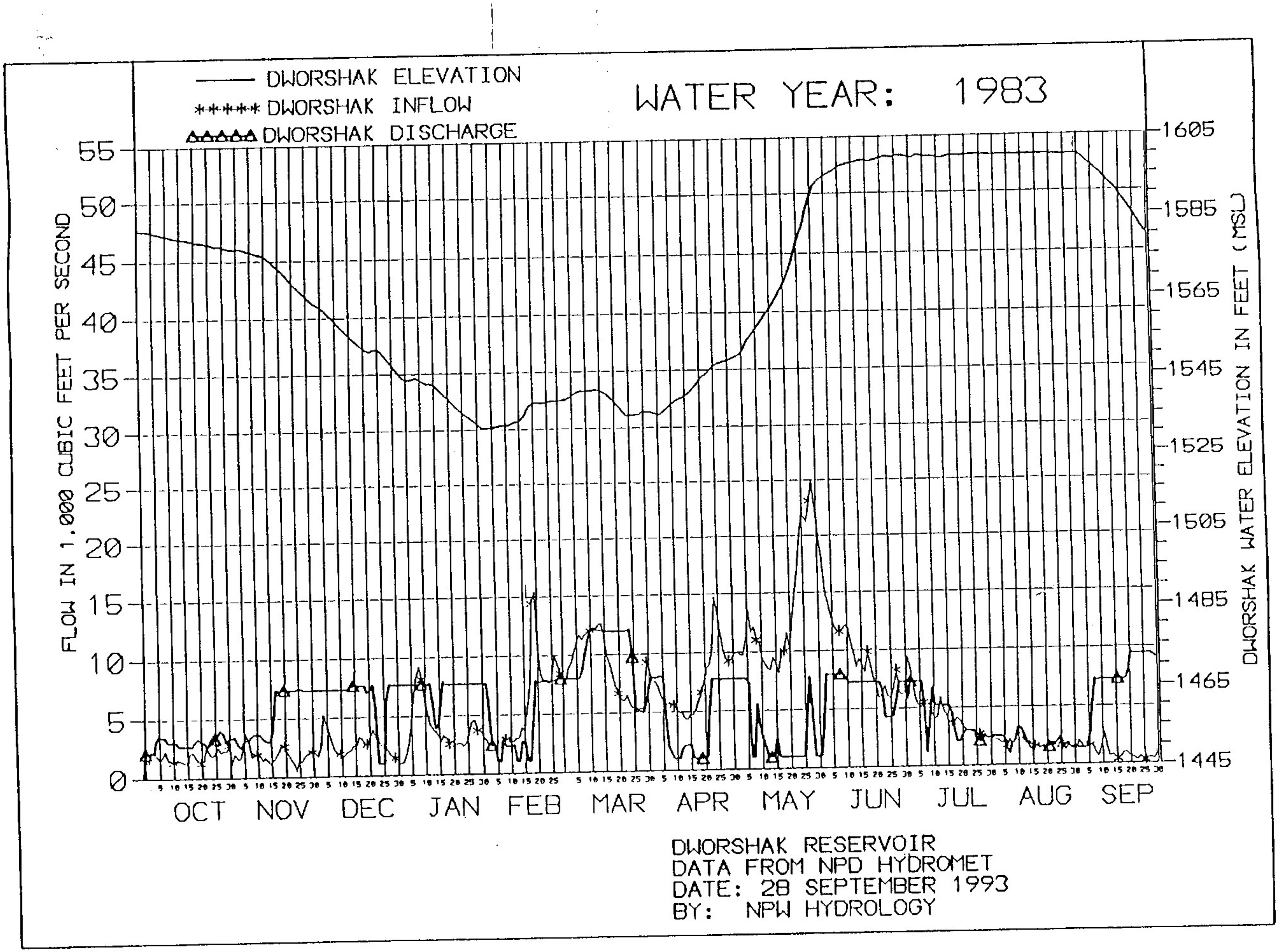

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DWORSHAK INFLOW
DWORSHAK DISCHARGE
WATER YEAR: 1983
FLOW IN 1,000 CUBIC FEET PER SECOND
DWORSHAK WATER ELEVATION IN FEET (MSL)
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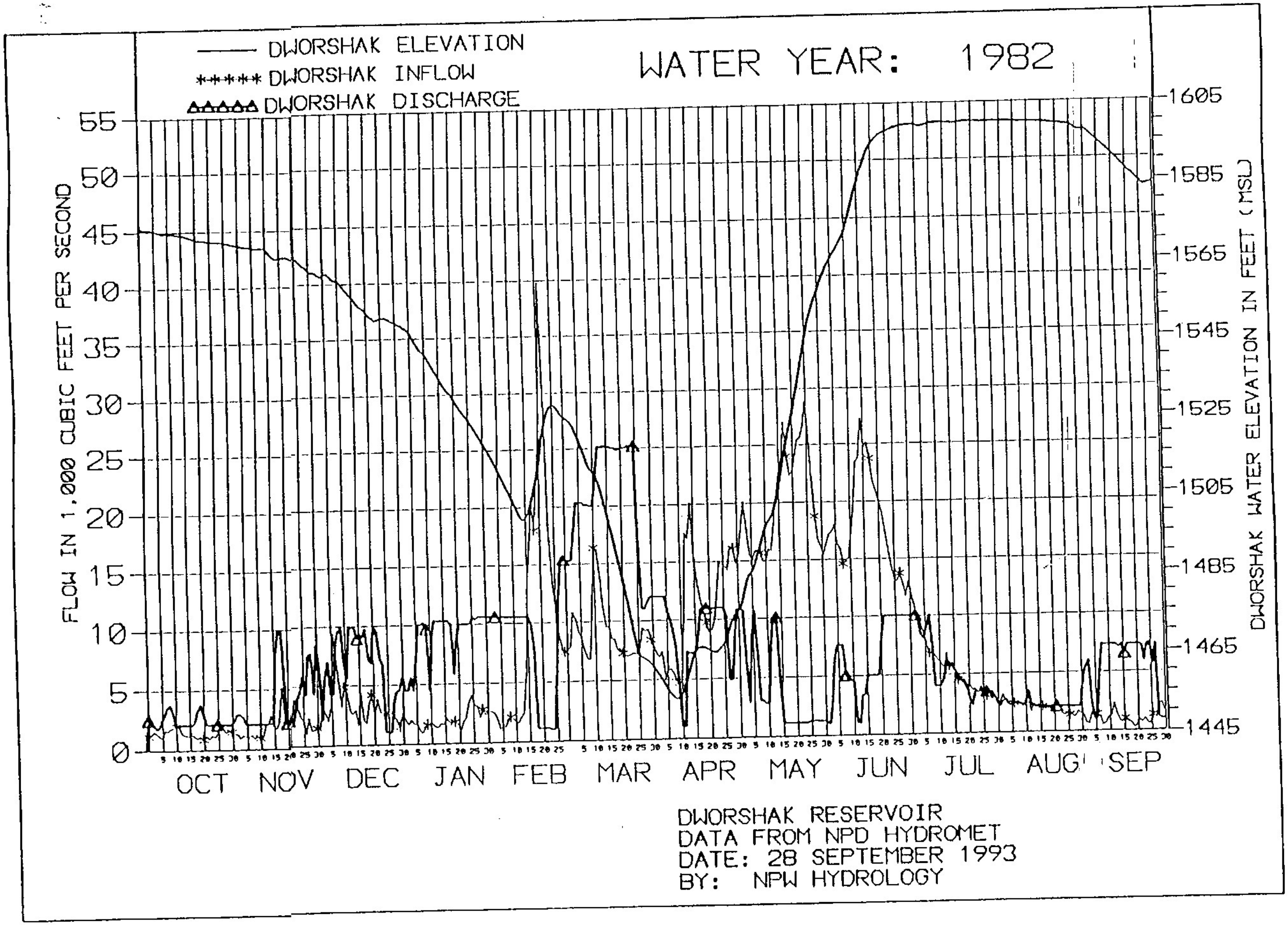


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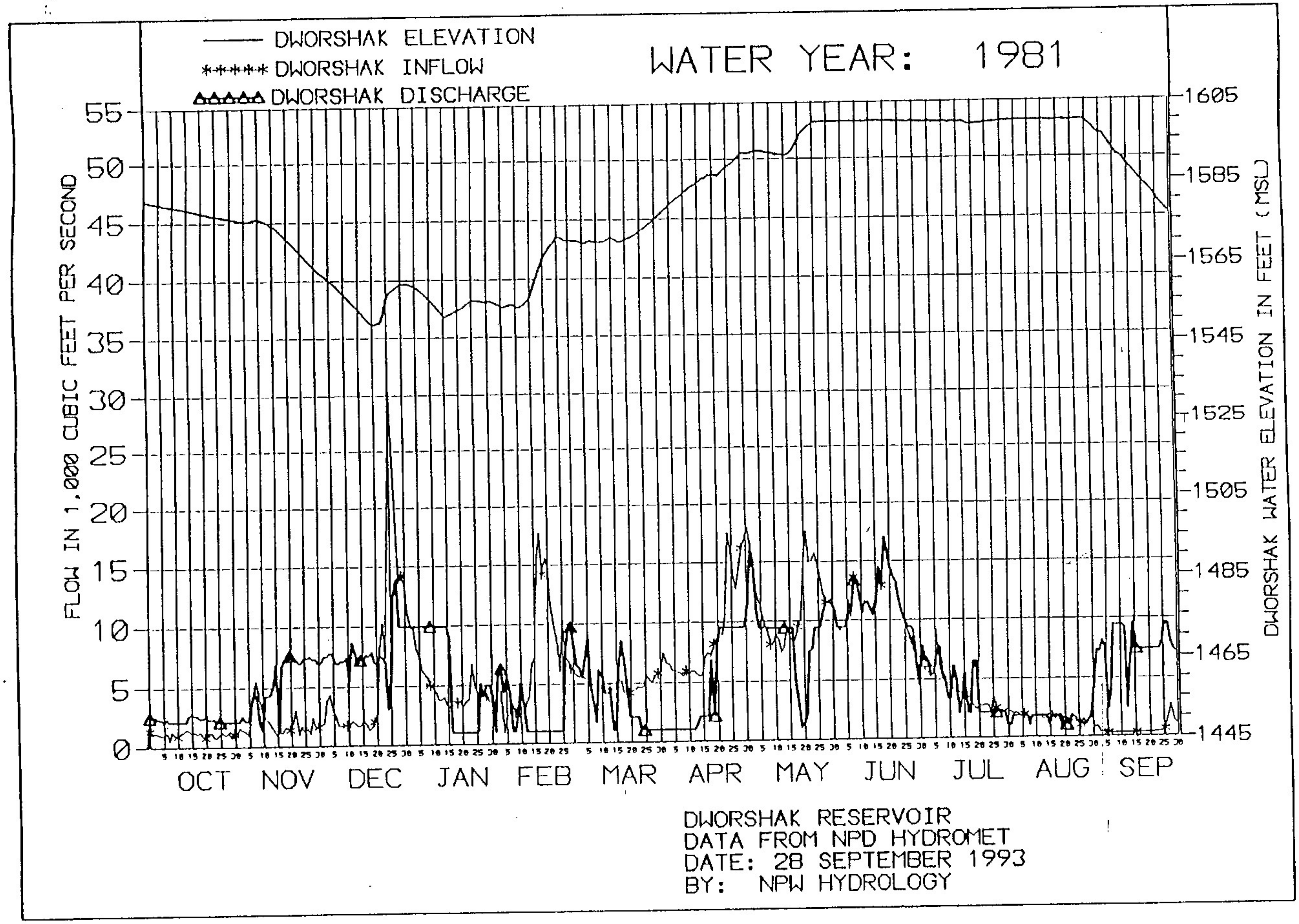

DWORSHAK ELEVATION
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DWORSHAK DISCHARGE
WATER YEAR: 1981
FLOW IN 1,000 CUBIC FEET PER SECOND
DWORSHAK WATER ELEVATION IN FEET (MSL)
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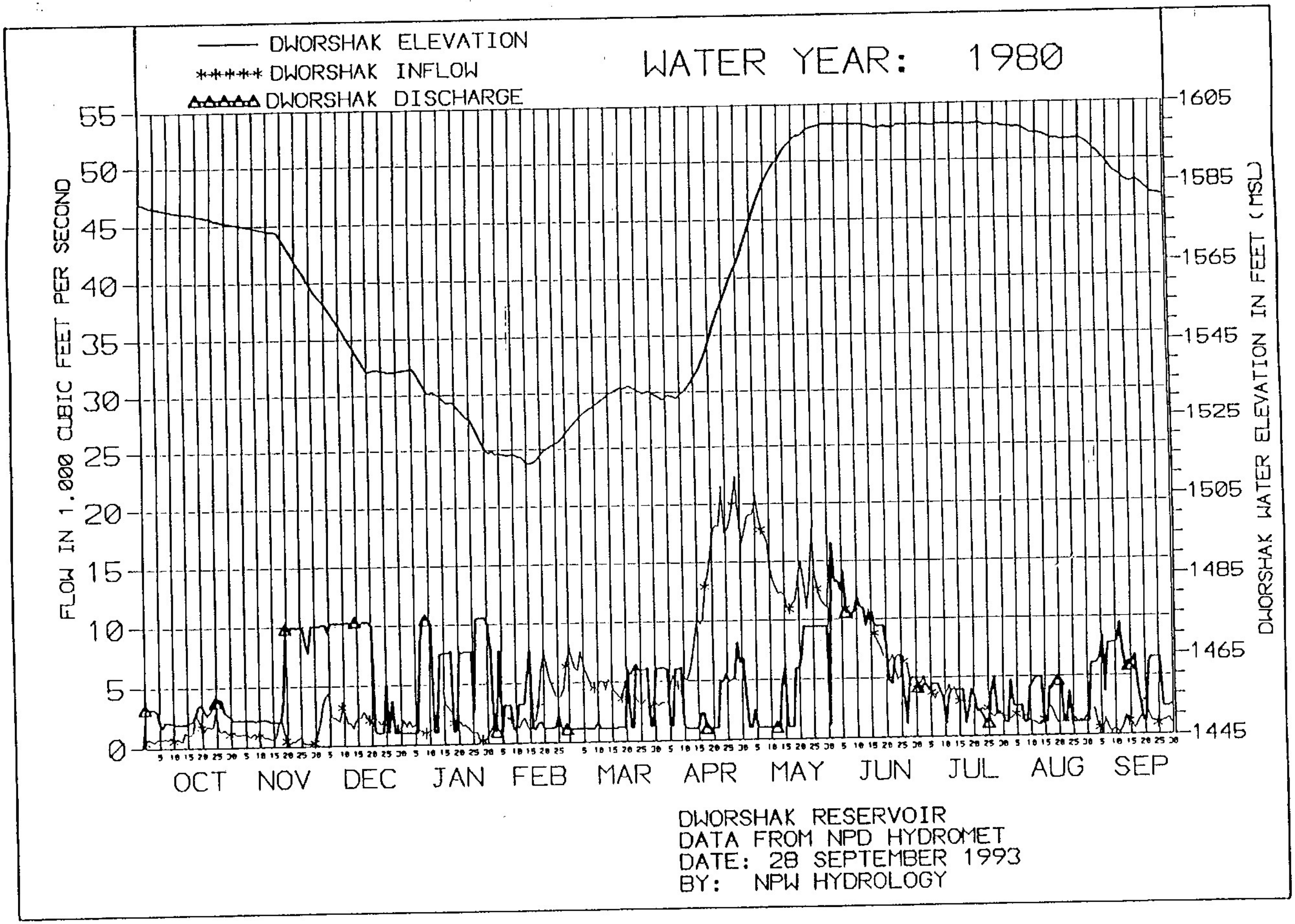

DWORSHAK ELEVATION
DWORSHAK INFLOW
DWORSHAK DISCHARGE
WATER YEAR: 1980
FLOW IN 1,000 CUBIC FEET PER SECOND
DWORSHAK WATER ELEVATION IN FEET (MSL)
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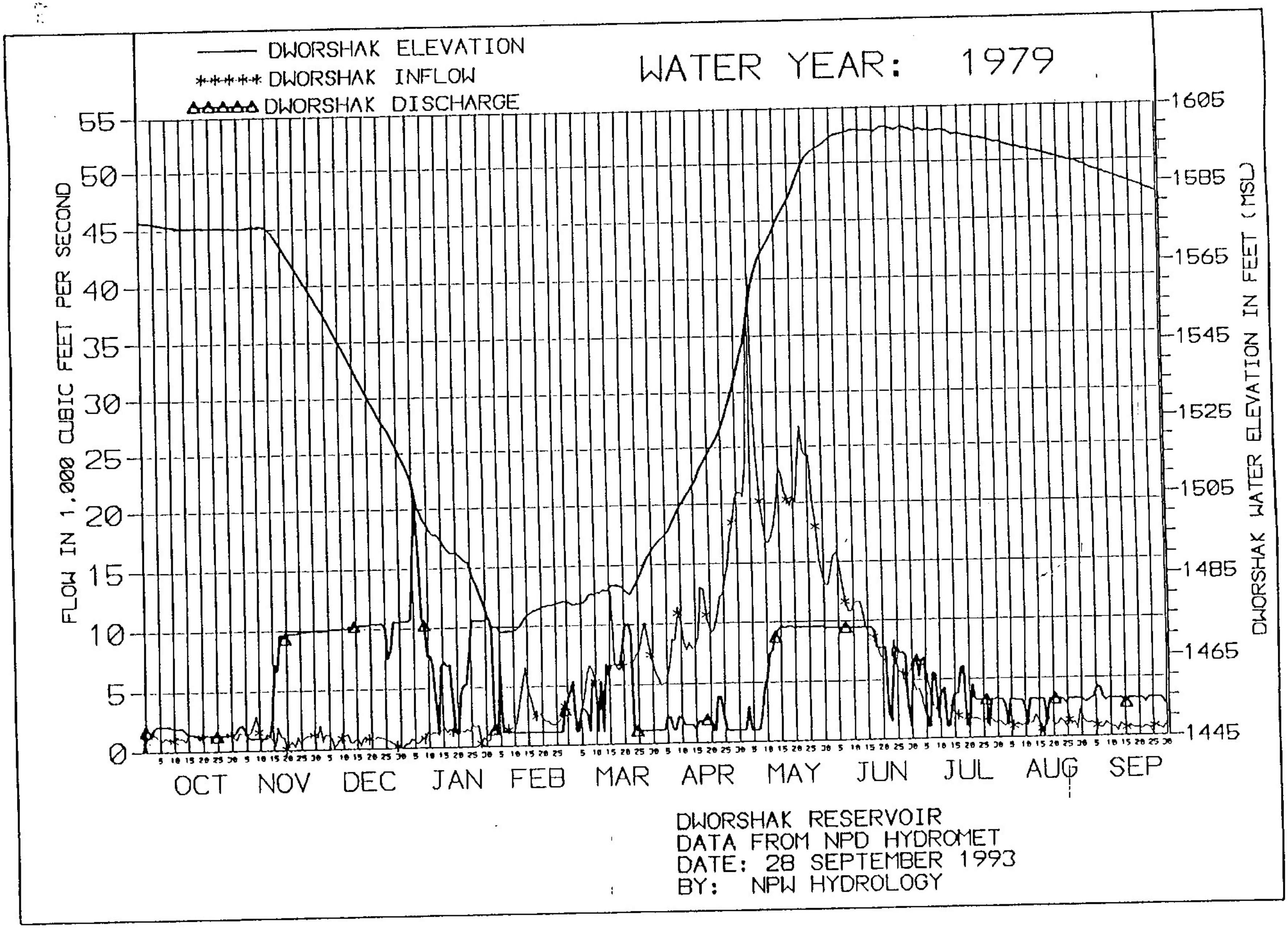

DWORSHAK ELEVATION
DWORSHAK INFLOW
DWORSHAK DISCHARGE
WATER YEAR: 1979
FLOW IN 1,000 CUBIC FEET PER SECOND
DWORSHAK WATER ELEVATION IN FEET (MSL)
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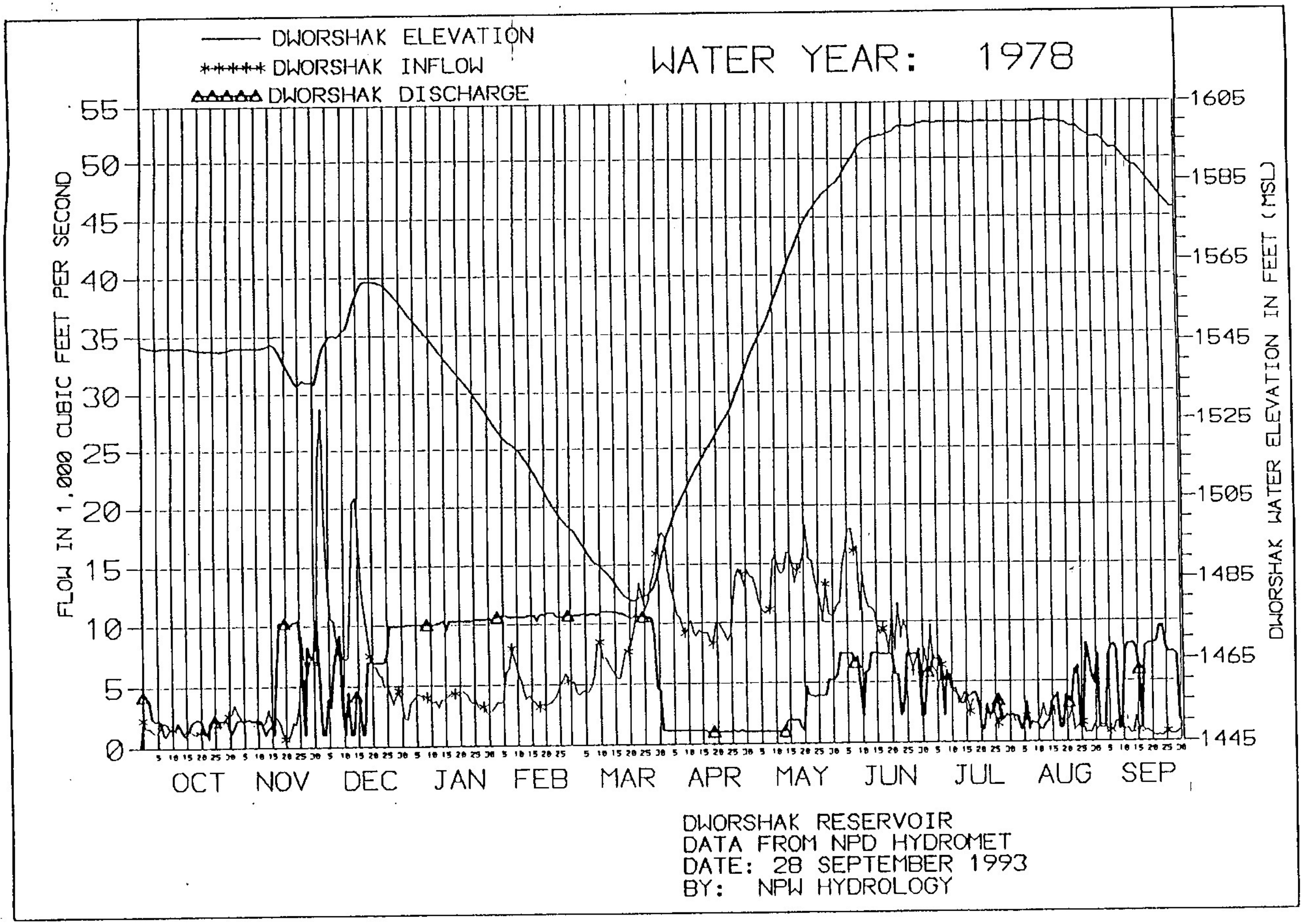

DWORSHAK ELEVATION
DWORSHAK INFLOW
DWORSHAK DISCHARGE
WATER YEAR: 1978
FLOW IN 1,000 CUBIC FEET PER SECOND
DWORSHAK WATER ELEVATION IN FEET (MSL)
0
5
10
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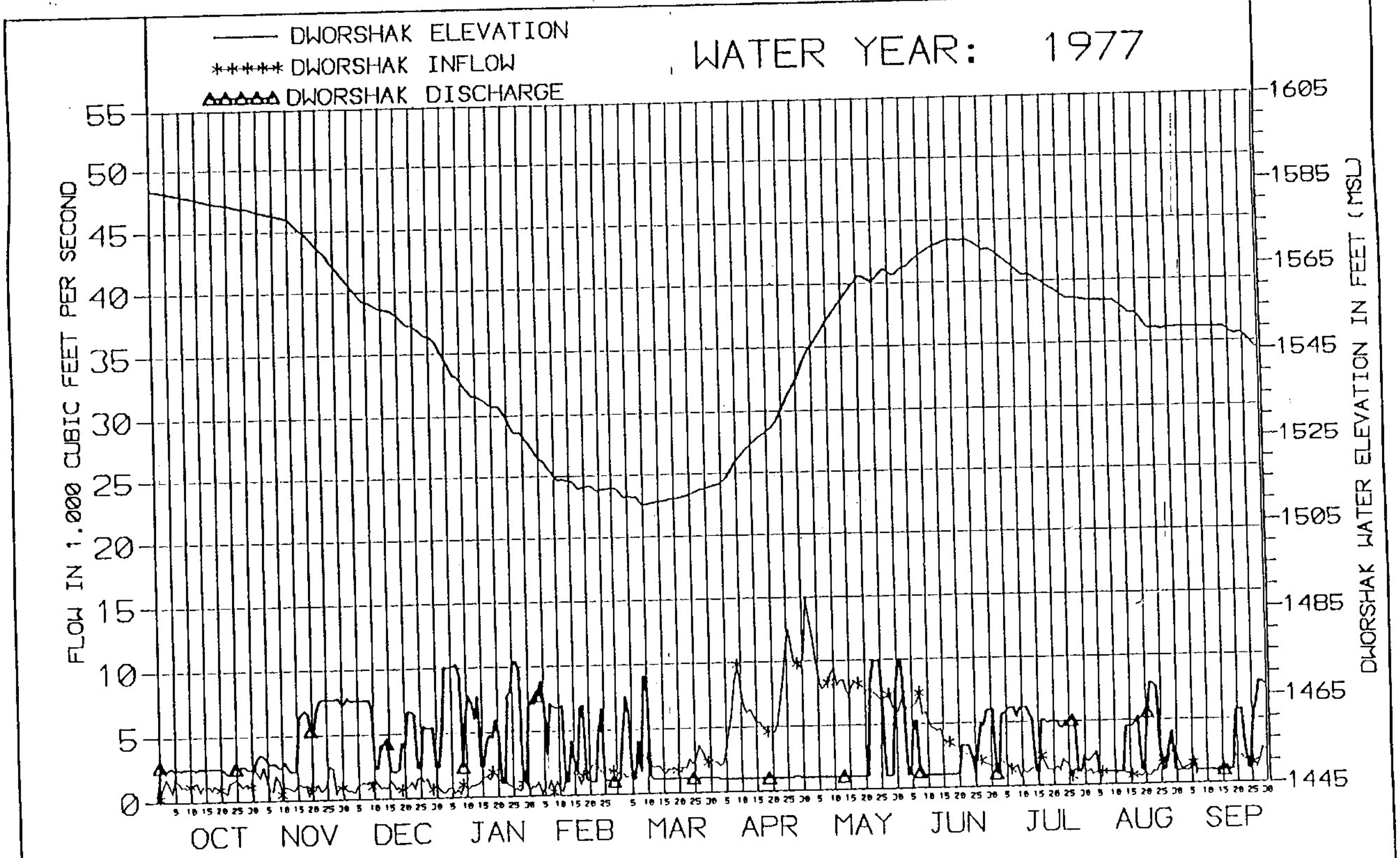


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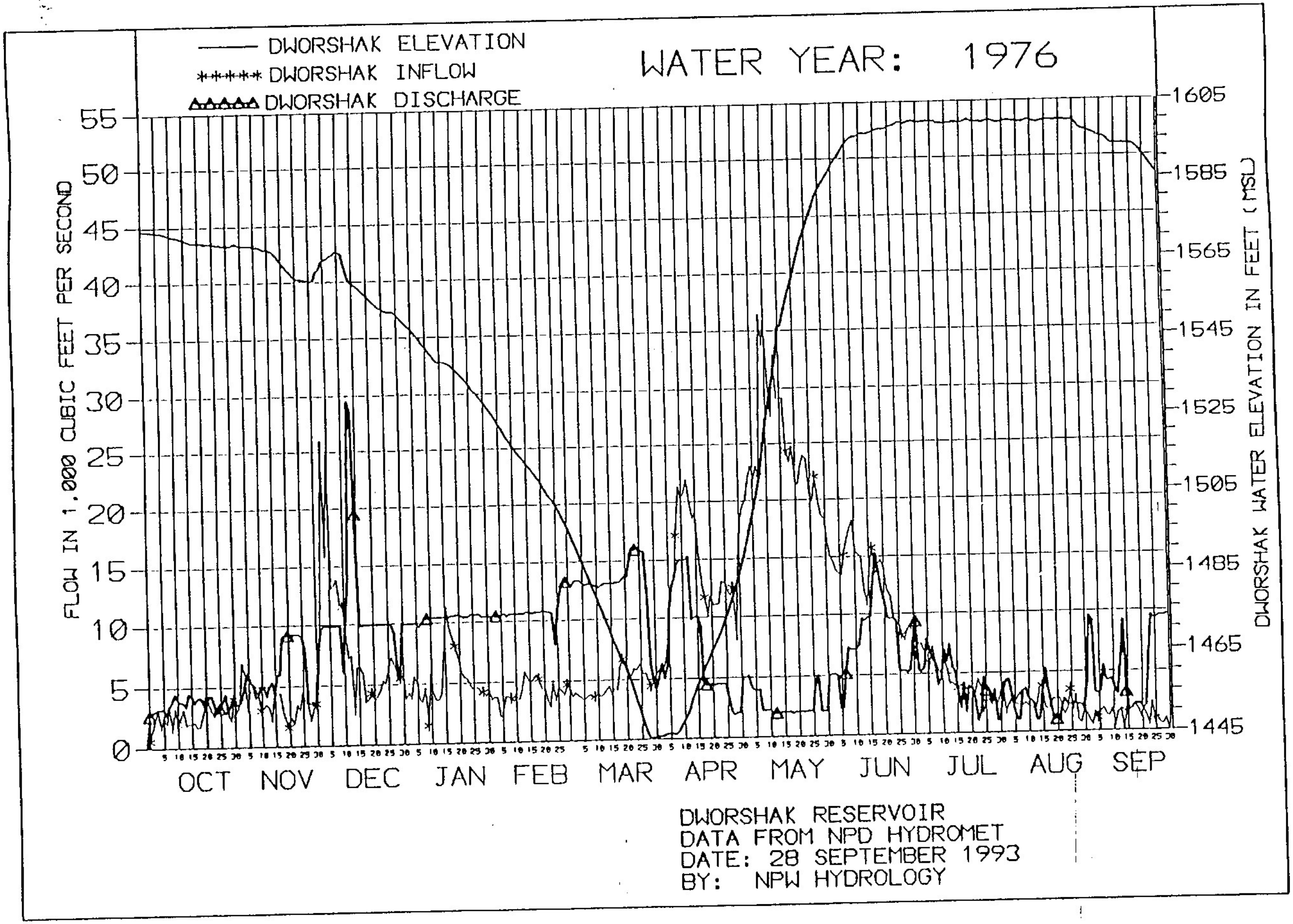

WATER YEAR: 1976
DWORSHAK ELEVATION
DWORSHAK INFLOW
DWORSHAK DISCHARGE
FLOW IN 1,000 CUBIC FEET PER SECOND
DWORSHAK WATER ELEVATION IN FEET (MSL)
0
5
10
15
20
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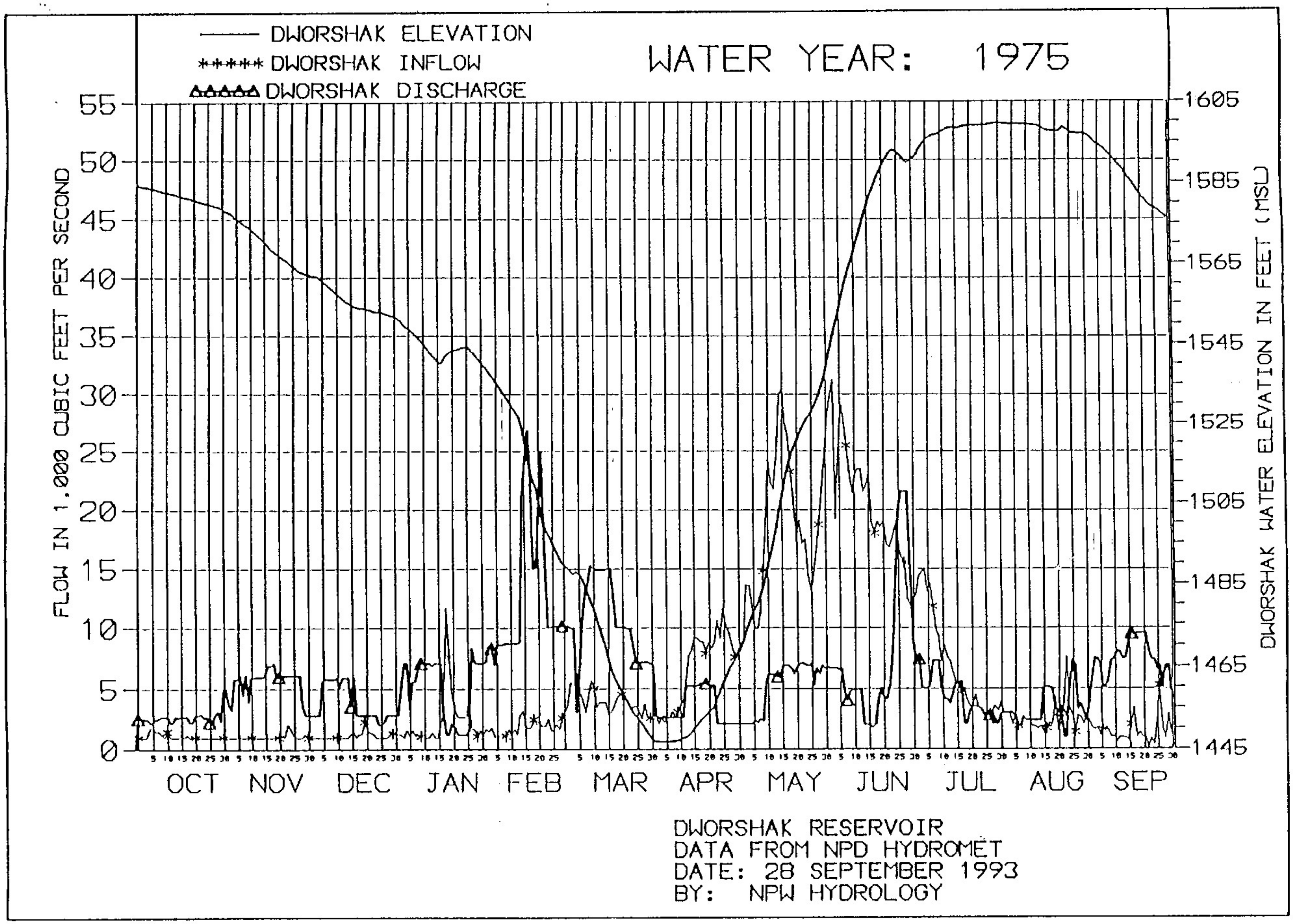

DWORSHAK ELEVATION
DWORSHAK INFLOW
DWORSHAK DISCHARGE
WATER YEAR: 1975
FLOW IN 1,000 CUBIC FEET PER SECOND
DWORSHAK WATER ELEVATION IN FEET (MSL)
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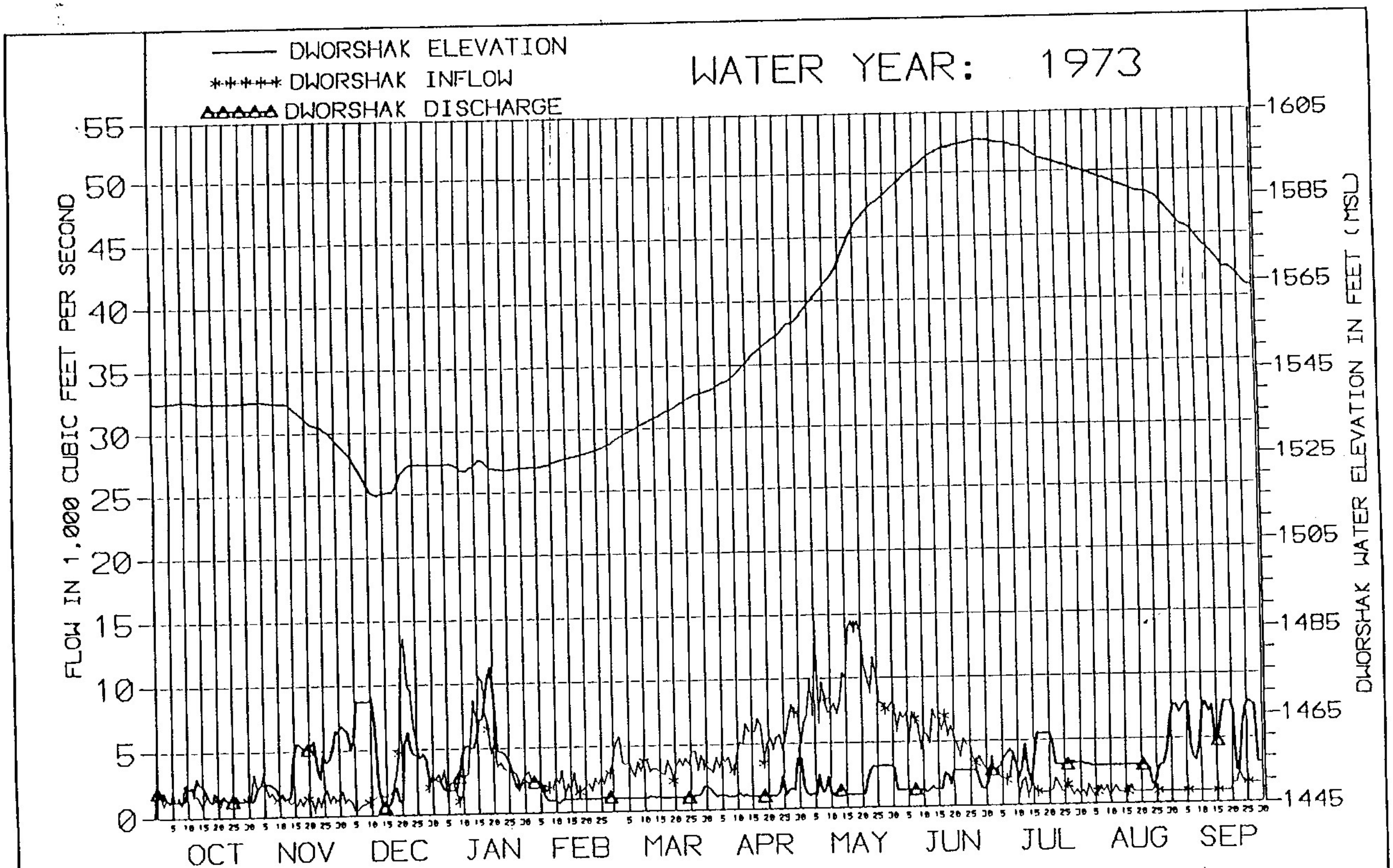

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