I. INTRODUCTION

PURPOSE *BASIN DESCRIPTION* *WATER RESOURCES DEVELOPMENT*
TYPES OF RESERVOIR PROJECTS *ANNUAL REGULATION CYCLE*

A. PURPOSE

This document reports on the activities of concerned governmental agencies relating to the operation of reservoirs and other associated water management activities in the Columbia River Basin and the Pacific Northwest during Water Year 2002 (October 2001 through September 2002). It is the 32nd "Blue Book" (known for the traditional color of its cover) prepared and published for the CRWMG (Columbia River Water Management Group), the interagency coordination group chartered by Federal and state agencies in the Pacific Northwest. The Columbia River system, with its many resources, requires the input of agencies with differing and sometimes conflicting resource needs to achieve the best overall use of this resource. The history of the CRWMG and its predecessor organization, the Columbia Basin Interagency Committee (CBIAC), is summarized in these reports and in 15 smaller annual reports produced by the CBIAC.

This report is a record of the activities surrounding the regulation of the major reservoirs in the Columbia River Basin with regard to their authorized purposes. It includes a description of the hydrologic conditions of weather, snowpack, streamflow, and hydrologic forecasts (Chapter II), narratives and graphics of project operation (Chapter III), a summary on the accomplishments associated with the system operations (Chapter IV), a summary of the meetings of the Group (Chapter V), and a short description of the Columbia River Treaty (Chapter VI). Appendices A and B contain static information on definitions and abbreviations on the major dams, powerhouses, and reservoirs in the Northwest. Appendix C contains graphic displays of the annual weather, project operation, and streamflow.

B. BASIN DESCRIPTION

This report discusses the past water year's water resource activities of the Pacific Northwest river systems, which includes those in the Columbia River basin and its tributaries (Figure 1). It includes most of Oregon and Idaho, most of Washington excluding the Puget Sound area and the Olympic peninsula, western Montana, southeastern British Columbia, and portions of Wyoming, Nevada, Utah, and California. The Columbia Basin itself covers 670,800 sq km (259,000 sq mi).

The dominant physiographic features of the Northwest are the Pacific Ocean, the mountain ranges and the Columbia River Basin. The Pacific Ocean affects the region because it is the source of all moisture entering the region. Three major mountain ranges, the Coast Range, the Cascade Range, and the Rocky Mountains, crossing the region in a roughly north-south direction, traverse the landmass. As storms are driven across the Northwest by the prevailing westerly winds, the mountains force the removal of moisture from the airmass, as indicated by the higher rainfall west of the mountains than in east-side valleys. The Coast Range (excluding the Olympic Mountains), with a few peaks that extend above 915 m (3000 ft), generally lies within 30 km (20 mi) of the Pacific Ocean. The Olympic Mountains also lie adjacent to the Pacific Ocean, but have a different geological history, have peaks above 2130 m (7000 ft). The 100 km (62 mi) wide Puget Sound/Willamette Valley trench, which extends from British Columbia to southern Oregon, separates the Coastal/Olympic and Cascade mountain ranges. The Cascades, a volcanic range with several peaks over 3050 m (10,000 ft), has an average crest elevation near 1830 m (6000 ft). East of the Cascade Range is the Columbia River Basin that drains the remainder of the Northwest. It is bordered on the east by the Continental Divide and the Rocky Mountains, on the south by the low divide into the Great Basins of Utah and Nevada, and on the north by the Monashee (a range within the Rockies) and Cascade mountains in British Columbia.

The Columbia River is the largest river in the Pacific Northwest and, with a length of 1953 km (1214 mi), is the 15th longest in North America. From its source at Columbia Lake at an elevation of 809 m (2650 ft) in Canada's Selkirk Mountains it first flows northwestward through eastern British Columbia, then turns southward toward the United States. It crosses the US-Canadian border north of Spokane, Washington, then flows southward across central Washington where it is joined by the Snake River, which drains southeastern Washington, eastern Oregon and southern Idaho. The Columbia then turns westward, forming the border between Washington and Oregon, flows through the Columbia River Gorge in the Cascade Mountains and on to its mouth at the Pacific Ocean near Astoria, Oregon.

The Columbia River ranks sixth in North America in terms of runoff after the Mississippi, MacKenzie, St Lawrence, Nelson, and Yukon rivers and is ranked 32nd among rivers of the world in area drained. The major tributaries to the Columbia are the Kootenai and Flathead/Pend Oreille rivers, which drain southeastern British Columbia, western Montana, and northern Idaho, the Snake River which drains western Wyoming, most of Idaho, eastern Oregon and southeastern Washington, and the Willamette River of western Oregon (Figure 2). Figure 3 denotes ten large basins located in coastal Washington, including Puget Sound, while Figure 4 denotes four large drainage basins located on the Oregon coast.

The climate of the region ranges from continental arid in parts of the Columbia Basin interior to alpine in the Coast and Cascade mountains to maritime rainforest in some coastal areas. In parts of eastern Washington, eastern Oregon, and the Snake River basin an average of less than 200 mm (8 in.) of precipitation occurs annually. In contrast, some the coastal mountain rain forests receive more than 5100 mm (200 in.) of annual precipitation.

C. WATER RESOURCE DEVELOPMENT

Before the river systems of the Northwest were developed, the water resources mainly provided habitat for fish and wildlife, with people living along the shoreline to use the available food sources and to use the rivers for transportation. However, with the growth of both settlement and industry, the rivers have been developed for additional uses to meet the needs of the region: energy production, water supply, recreation, and flood control.

The first navigation locks constructed in the region were those on the Willamette River at Oregon City in 1873, which allowed navigation around the Willamette Falls, and in 1876 on the Columbia River two miles upstream of the present day location of Bonneville Dam, which allowed navigation around the treacherous cascades. The Willamette Locks are still in operation while the Cascade Locks were no longer needed when the construction of Bonneville Dam and Locks provided slack-water navigation up to The Dalles, Oregon. The lock walls, without the gates, can still be seen in the park at Cascades Locks, Oregon.

Hydroelectric development in the Northwest began in the late 1880's when electric "dynamos", now called generators, were installed on the Spokane River in Spokane, on the Willamette River at Oregon City, and on the Snoqualmie River at Snoqualmie Falls, east of Seattle. Harnessing the energy of the mainstem Columbia River did not begin until the Chelan County PUD #1 completed the construction of Rock Island Dam near Wenatchee in 1932, followed closely by the construction of Grand Coulee and Bonneville dams in the late 1930's. Bonneville was constructed with state-of-the-art fish ladders to assist the passage of returning salmon.

There were two other main periods of federal dam construction in the basin. The first was in the 1950's when Hungry Horse, Chief Joseph, The Dalles, McNary, Albeni Falls, and Ice Harbor dams were built, and the second was in the mid-1970's when the Columbia River Treaty projects (Libby, Mica, Duncan, and Keenleyside), Dworshak, and three lower Snake projects (Lower Granite, Little Goose, Lower Monumental) were built. Most of the construction of public utility and privately owned dams was also during these periods.

The river resource development responded to the region's population that had grown from approximately 2.8 million in 1933 to more than eight million today. Storage projects on the Columbia and lower Snake basins contain more than 53 billion cubic meters (43 million acre-ft) of usable flood control space and were authorized primarily for flood control, hydroelectric energy generation, irrigation, and navigation. Other uses include fish and wildlife enhancement, recreation, low-flow augmentation, and both municipal and industrial water supply. Figure 5 is a schematic drawing of the interrelationship of the operation of the projects in the Northwest. It also includes some of the key streamgages whose data are used in regulating the many reservoirs in the region.

D. TYPES OF RESERVOIR PROJECTS

Many so-called "reservoir" projects are actually "run-of-river," or "pondage" projects that have little or no storage capacity in comparison to their streamflow. Since these projects cannot store streamflow they generate electric energy with the water as it flows past the project. Bonneville, The Dalles, and McNary on the lower Columbia, the projects on the mid-Columbia (Priest Rapids to Chief Joseph), and Ice Harbor to Lower Granite on the lower Snake River are examples of pondage projects.

Some projects are designed specifically for daily re-regulating of outflows from an upstream project. Big Cliff and Dexter Reservoirs in the Willamette Basin are examples of this type of reservoir, because they regulate and smooth out the peaking discharges caused by fluctuations in power generation at Detroit and Lookout Point dams, respectively, while their own outflows remain relatively constant.

A true storage reservoir is one that generally fills and drafts on an annual cycle. Some are "annual" storage reservoirs that are drafted to the minimum conservation pool and yet refill every year. Foster, Pend Oreille Lake, and Kootenay Lake are examples of annual reservoirs. Other storage reservoirs are "cyclic" because they may not refill each year. The amount of drawdown of cyclic reservoirs is based on volume inflow forecasts. Dworshak, Libby, Hungry Horse, Mica, Keenleyside, and Duncan dams are examples of cyclic reservoirs.

Another feature of storage reservoirs is the existence of at-site power generating facilities. Most annual and cyclic projects also have powerhouses to generate electric energy by releasing the water they have in storage. However, Duncan Dam does not have at-site generation but yet has significant power benefits because water released from it can be timed to passes through many powerhouses downstream at times of peak power demands and, therefore create additional benefits.

E. ANNUAL REGULATION CYCLE

There are two different regulation cycles for storage reservoirs in the Northwest. In the Northwest interior, where springtime snowmelt is the main source of river flows in the Columbia River, water is released from reservoirs during the cold winter period to generate electricity to meet the higher power demands and to prepare the reservoirs to store the snowmelt of the next spring and summer. In years with large snowfalls, flood control requirements may require additional drafting before snowmelt begins. The reservoirs are then filled during the snowmelt period, April through August, retaining the stored water for the next cycle and achieving flood control objectives in the process. After filling, the reservoirs generally remain as full as possible until the end of the summer recreation season, then they are lowered again to repeat the cycle of power generation and drafting for the next summer’s flood control. Irrigation reservoirs follow a similar filling regime but begin drafting their storage as irrigation demands increase in spring and summer.

West of the Cascade Mountains, where much of the winter precipitation falls as rain, the regulation is quite different. During the late summer and fall, reservoirs are lowered (drafted) to provide flood control space for possible winter rain-produced floods. Winter drafting of reservoir below set flood control limits, even for electric power generation, may reduce the chances of spring refill for summer use as flow augmentation and recreation. If winter flood control operation is required, the stored water is released as soon as possible after the flood to regain storage space for controlling subsequent floods. Most of the reservoirs west of the Cascades begin seasonal refilling during February in proportion to the decreasing magnitude and possibility of flooding. This operation continues until the reservoirs finally reach their maximum level which is normally during late May. The reservoirs are usually held as full as possible during the summer for recreational use, although some downstream water uses may require some reservoir drafting. Drawdown must begin in the fall so that by November or early December there is ufficient storage space for winter flood control.