

## APPENDIX A

### GLOSSARY

The following glossary contains an alphabetical listing of most of the key technical terms used in operational hydrology. For a graphic illustration of reservoir terms see Figures A1 and A2.

**ACRE-FOOT** - a unit of volume equal to one acre of area by one foot depth (equal to 43,560 ft<sup>3</sup> or 325,872 gallons). This unit is generally used to measure the volumes of water used or stored in reservoirs. Also used are thousands of acre-feet (kaf) and millions of acre-feet (maf).

**ACTIVE STORAGE** - water occupying active storage capacity of a reservoir.

**ACTIVE STORAGE CAPACITY** - the portion of the live storage capacity in which water normally will be stored or withdrawn for beneficial uses, in compliance with operating agreements or restrictions.

**ADJUSTED STREAMFLOW** - observed streamflow adjusted to eliminate effects of specified controls.

**ADVERSE HISTORICAL STREAMFLOW SEQUENCE** - see critical streamflow period.

**ASSURED REFILL CURVE (ARC)** - indicates the end-of-month storage content which would assure refill of a seasonal reservoir based on a specified historical volume of inflow for the whole or remaining portion of the refill period. The specified historical value for most projects in the Columbia basin is the second lowest of historical record. The year 1931 represents the second lowest of historical January-July volume inflows for the system as measured at The Dalles, Oregon.

**ASSURED SYSTEM CAPACITY** - the dependable capacity of system facilities available for serving system load after allowance for required reserve capacity, including the effect of emergency interchange agreements and firm power agreements with other systems.

**AVERAGE** - the sum of the items divided by the number of items; for other than the 1961-90 normal period. See also NORMAL.

**AVERAGE STREAMFLOW** - the average rate of flow at a given point during a specified period.

**BANKFULL STAGE** - The stage at which a stream first overflows its natural banks. (See also FLOOD STAGE. Bankfull stage is a hydraulic term whereas flood stage implies damage.)

**BASE ENERGY CONTENT CURVE** - The higher of the assured refill curve and the first year critical rule curve.

**BASE LOAD** - the minimum load in a stated period of time.

**BASE LOAD PLANT** - a power plant which is normally operated to carry base load and which, consequently, operates essentially at a constant load.

**BASE POWER FLOW** - observed streamflow adjusted to eliminate the effects of reservoirs, controlled lake regulation, and actual Grand Coulee pumping and then further adjusted to a given level of irrigation development.

**BIOLOGICAL OPINION** - A set of recommendations from NMFS defining what operations the Columbia River system operation should be in order to ensure that the endangered species are not placed into jeopardy.

**BRIGHT** - a fall chinook salmon that spawns in the upper river, say, above the Umatilla River, that enters the lower Columbia River in a bright silver condition but that has not yet begun its spawning metamorphosis. See also Tule.

**CAPABILITY** - the maximum load which a generator, turbine, transmission circuit, apparatus, station, or system can supply under specified conditions for a given time interval, without exceeding approved limits of temperature and stress.

**CAPACITY** - the load for which a generator, turbine, transformer, transmission circuit, apparatus, station, or system is rated. Capacity is also used synonymously with capability. NOTE: For definitions pertinent to the capacity of a reservoir to store water, see Reservoir Storage Capacity.

**CONNECTED LOAD** - the sum of the ratings of the electric power consuming apparatus connected to the system, or part of the system, under consideration.

**COLUMBIA BASIN TELECOMMUNICATIONS (CBT)** - the CBT is a medium speed leased line teletype communication system between major power producing projects, the agencies responsible for their operation, and

the operating/forecasting agencies. This system is used to transmit hydrologic data and reservoir operating instructions necessary for efficient project operation. This system replaced the older Columbia Basin Teletype network (CBTT) in 1983.

**COORDINATED SYSTEM RESERVOIRS** - the agencies of the Pacific Northwest who have ratified 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 became effective on January 4, 1965, and terminates on June 30, 2003. The member agencies are:

Bonneville Power Administration	The Montana Power Company
Corps of Engineers	Pacific Power and Light Company
Bureau of Reclamation	Pend Oreille County PUD #1
Chelan County PUD #1	Portland General Electric Company
Colockum Transmission Company	Puget Sound Power and Light Company
Cowlitz County PUD #1	Seattle City Light
Douglas County PUD #1	Tacoma City Light
Eugene Water and Electric Board	The Washington Water Power Company
Grant County PUD #2	

**CONTINUOUS POWER** - hydroelectric power available from a plant on a continuous basis under the most adverse hydraulic conditions contemplated.

**CRITICAL PERIOD** - period when the limitations of hydroelectric power supply due to water conditions are most critical with respect to system load requirements. This is the 42-1/2 month historical sequence of streamflows that occurred from August 16, 1928, through February 29, 1932. Also called Critical Hydro Period and Critical Streamflow Period.

**CRITICAL RULE CURVE (CRC)** - a schedule or budget of seasonal reservoir drafts, with respect to time, as determined from analysis of estimated loads and calculated resources based on critical flow water supply for the period. In the analysis, consideration is given first, to providing power so as to meet system firm loads; second, to economy of operation; and third, to providing power to meet interruptible loads. The schedule or budget of reservoir draft may be shown as a plot of reservoir elevation with respect to time, energy producible from reservoir draft with respect to time or by other similar means.

In multiple-year critical periods there will be a Critical Rule Curve for each corresponding year of the critical period, the first year's curve being the highest in indicated storage energy, the second year's being the next highest, etc.

**CUBIC FEET PER SECOND (cfs)** - unit of measure expressing rates of discharge. Also expressed as thousand cubic feet per second (kcfs).

**DEAD STORAGE** - the volume in a reservoir below the invert of the lowest controllable outlet.

**DEAD STORAGE CAPACITY** - the volume of a reservoir which is below the invert of the lowest outlet and cannot be evacuated by gravity.

**DEMAND** - the rate at which electric energy is delivered to or by a system, part of a system, or piece of equipment, expressed in kilowatts or other suitable unit, at a given instant or averaged over any period of time.

**DEPLETIONS** - Over the past 50 or more years, the natural streamflow patterns in the Columbia Basin have been altered by the gradual development of nearly 43 million acre-feet (53,000 hm<sup>3</sup>) of reservoir storage and by nearly 8 million acres (3,240,000 hm<sup>2</sup>) of land for irrigation. Storage reduces high flows when reservoirs are filling and increases low flows when storage is released. Irrigation not only alters the stream flow pattern by withdrawing water from the rivers but also depletes the water supply through evaporation and infiltration. Consequently, to more accurately compare historical streamflow records, these changes must be taken into consideration. This is done by the "depletions" process in which streamflow data are modified, on a monthly basis, by adjusting flows for both the storage changes in all major lakes and reservoirs and for the irrigation adjustments to a common time of development. The historical records for the Columbia basin have been "depleted" by the Depletions Task Force (DTF) of the CRWMG.

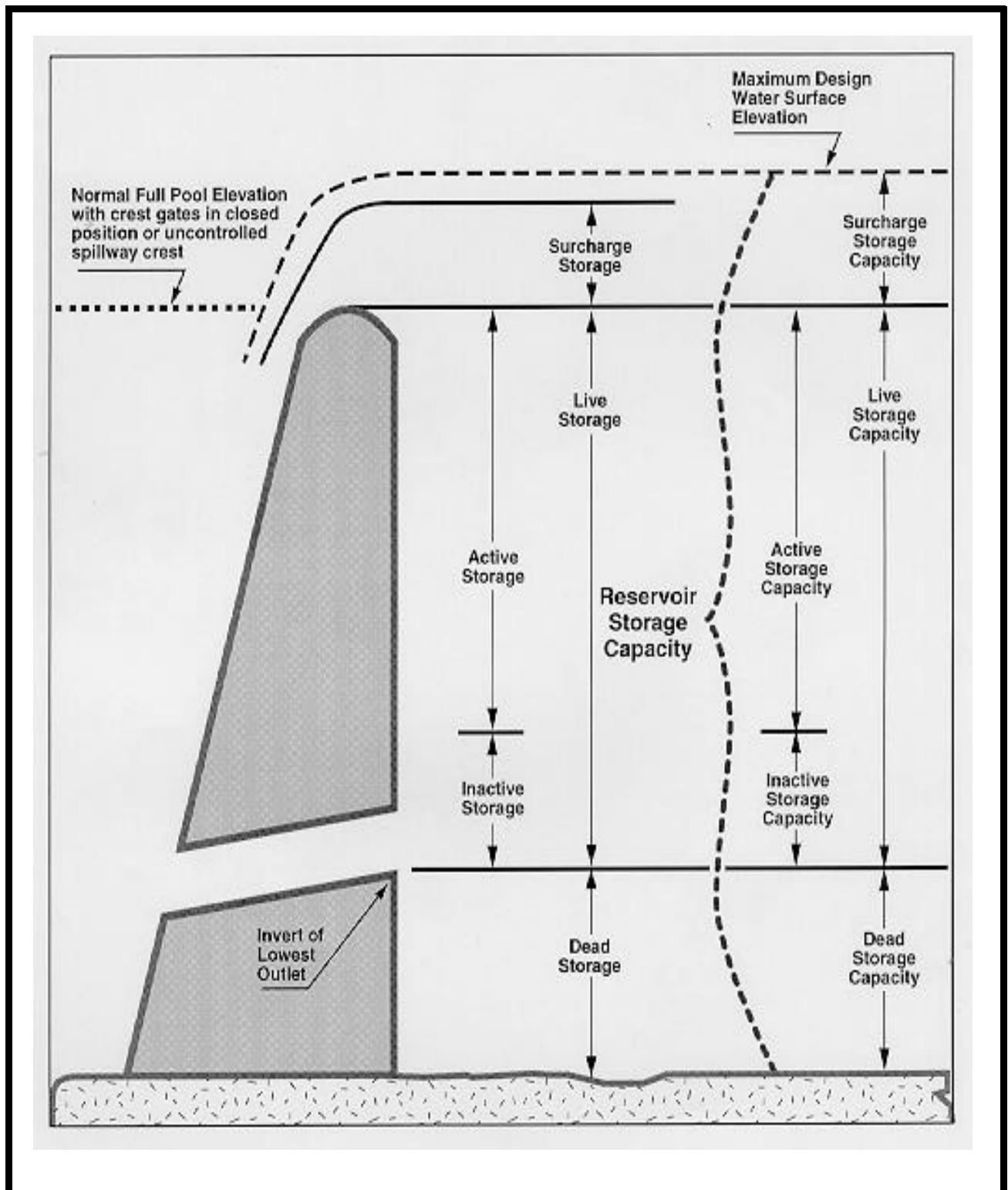
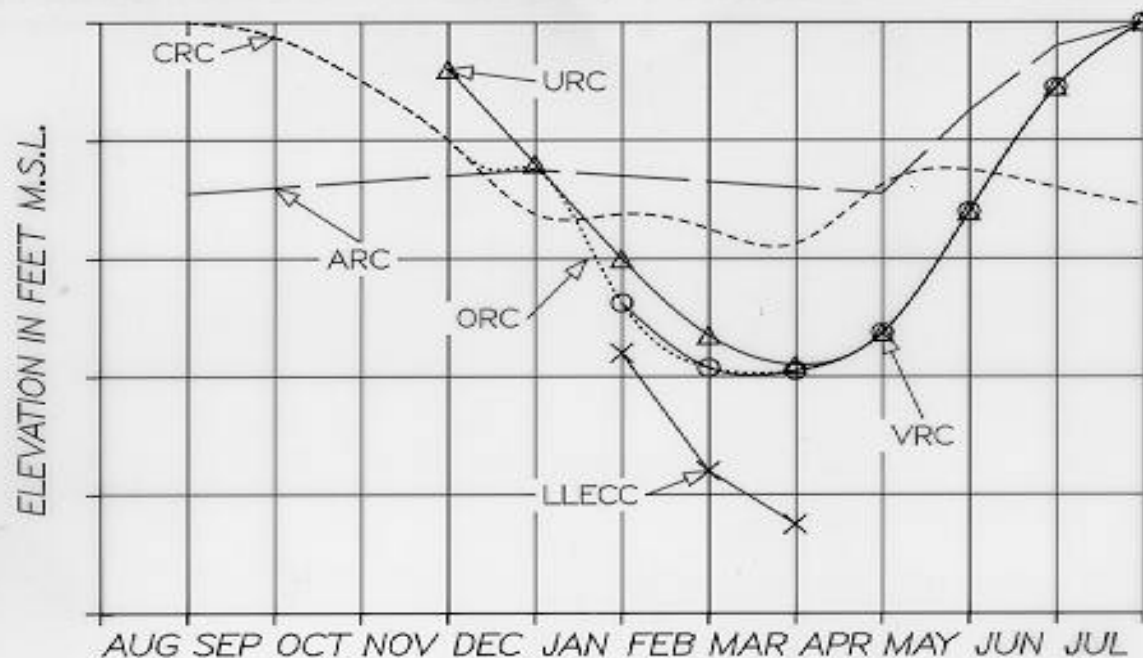


Figure A-1. ILLUSTRATION OF RESERVOIR TERMS



1. **CRITICAL RULE CURVE (CRC).** This curve is actually a family of one to four curves depending on the length of the critical period. These curves are developed in July of each operating year from historical flows and based on operating under adverse flow conditions.

2. **ASSURED REFILL CURVE (ARC).** This curve is the elevation that each project can refill if the second lowest historical water year (1931), January thru July run-off should occur.

3. **VARIABLE REFILL CURVE (VRC).** This curve depicts the reservoir elevation needed to refill with 95 % assurance based on the current run-off forecast.

4. **UPPER RULE CURVE (URC).** This curve for the period August thru December is based on historical flows and for the period January thru July is based on forecast flows. The URC reflects the amount of storage space needed to protect against a flood.

5. **LOWER LIMIT ENERGY CONTENT CURVE (LLECC).** This curve serves as a limit on the project draft in January, February, and March to protect the system's capability to meet firm loads until the start of the spring runoff. Limits are determined by using 1936-1937 water year to meet the system's firm energy loads.

6. **OPERATING RULE CURVE (ORC).** (August thru December) The ORC is the higher of the ARC or the CRC unless the URC is lower, then it controls. (January thru March) The ORC method is the same as August thru December period unless the VRC is lower, then it controls. When the VRC controls the ORC can be higher than the URC. But in no case can the ORC be lower than the LLECC. (April thru July) The ORC method is the same as January thru March period, except without the LLECC consideration.

**Figure A-2. RULE CURVE DEFINITIONS**

**DISCHARGE** - the rate of flow of a river or stream measured in volume of water per unit of time. The standard units of measure are cubic feet per second (cfs) or thousand cubic feet per second (kcfs).

**DIVERSION DEMAND** - the amount of water withdrawn from surface or groundwater sources.

**DRAWDOWN** - the distance that the water surface of a reservoir is lowered from a given elevation as the result of the withdrawal of water.

**EFFICIENCY, STATION OR SYSTEM** - the ratio of the energy delivered from the station or system to the energy received by it under specified conditions.

**ELECTRIC POWER** - a term used in the electric power industry to mean inclusively power and energy.

**ENDANGERED SPECIES** - any species which, as determined by the Fish and Wildlife Service, is in danger of extinction throughout all or a significant portion of its range other than a species of the class Insecta determined to constitute a pest whose protection would present an overwhelming and overriding risk to man.

**ENERGY** - that which does or is capable of doing work. It is measured in units of the work; electric energy is usually measured in kilowatt hours.

**ENERGY CONTENT CURVE (ECC)** - provides sufficient storage at all times so that the Coordinated System will be able to generate its Firm Energy Load Carrying Capability under a recurrence of any historical streamflow sequence. The ECC is obtained the same way as the Operating Rule Curve (defined in Figure A-2) except the proportional draft point needed to generate the Firm Energy Load Carrying Capability is also part of the ECC.

The curve is a guide to the use of storage water from each reservoir and is used to define certain operating rights, obligations and limitations. The ECC for each reservoir consists of a graphic, tabular or other representation of reservoir elevations at the end of specified periods.

**EXTRA HIGH VOLTAGE (EHV)** - a term applied to voltage levels of transmission lines which are higher than the voltage levels commonly used. At present, the electric industry generally considers EHV to be any voltage greater than 230,000 volts.

**FEDERAL COLUMBIA RIVER POWER SYSTEM RESERVOIRS** - the Federally-owned projects that generate hydroelectric power include the following existing and planned projects:

Albeni Falls	Hungry Horse
Anderson Ranch	John Day
Big Cliff	Ice Harbor
Black Canyon	Libby
Boise Diversion	Little Goose
Bonneville	Lookout Point
Chandler	Lost Creek
Chief Joseph	Lower Granite
Cougar	Lower Monumental
Detroit	McNary
Dexter	Minidoka
Dworshak	Palisades
Foster	Roza
Grand Coulee, incl	Strube (Cougar Reregulator) <sup>1</sup>
Pumped Storage and	Teton <sup>2</sup>
Third Powerplant	The Dalles
Green Peter	
Green Springs	<sup>1</sup> Planned.
Hills Creek	<sup>2</sup> Status undetermined.

**FINGERLING** - Fish whose size ranges from approximately 1 to 3 inches.

**FIRM ENERGY** - electric energy which is intended to have assured availability to the customer to meet all or any agreed upon portion of his load requirements.

**FIRM ENERGY LOAD CARRYING CAPABILITY (FELCC)** - the firm energy load that a system is able to supply in any period after deducting the required energy reserve and Forced Outage Reserve.

**FIRM POWER** - power intended to have assured availability to the customer to meet all or any agreed upon portion of his load requirements.

**FISHPASS** - a computer model developed by the Corps of Engineers to simulate anadromous smolt migration and survival as they travel through a river system. It allows analysis of the impacts of proposed migration such as the Water Budget fish screens, fish spill, and fish transportation on juvenile fish survival through river systems and past dams.

**FLASH FLOOD** - a flood with a very rapid rate of rise that is generally caused by intense rainfall, failure of ice jams or dams, etc. They occur in small drainages and the time between the peak rate of rainfall and the peak discharge is very small.

**FLOOD CONTROL RULE CURVE** - a curve or family of curves of reservoir contents, with respect to time, indicating space required to control flood flow. These curves are determined from analysis of magnitude, duration, and potential damage of flood flows throughout the year or for certain periods during the year. Also called Mandatory Rule Curve (MRC).

**FLOOD PLAIN** - the low lands adjoining the channel of a river, stream, watercourse, lake, or ocean, that have been or may be inundated by flood waters and other areas subject to flooding.

**FOREBAY** - that area of a reservoir immediately upstream of a dam and in the vicinity of the outlet structures.

**FLOOD STAGE** - The stage at which the overflow of the natural banks of a stream begins to cause damage in the reach in which the elevation is measured. (See BANKFULL STAGE.)

**FORCED OUTAGE** - the shutting down of a generating unit, transmission line, or other facility, for emergency reasons.

**FRY** - The stage in the life of a fish between the hatching of the egg and the absorption of the yolk sac. From this stage until they attain a length of one inch the young fish are considered advanced fry.

**FUEL REPLACEMENT ENERGY** - electric energy generated at a hydroelectric plant as a substitute for energy which would otherwise have been generated by a thermal-electric plant.

**GENERATING UNIT** - an electric generator together with its prime mover.

**GENERATION** - act or process of producing electric energy from other forms of energy; also the amount of electric energy so produced.

**HABITAT** - the natural abode of a plant or animal, including all biotic, climatic, or soil conditions or other environmental influences affecting life.

**HATCHERY FISH** - fish that are reared from fertilization in a hatchery environment.

**HISTORICAL STREAMFLOW** - synonymous with observed streamflow over the period of record.

**HYDROELECTRIC PLANT** - an electric power generating plant in which turbine-generator units are driven by falling or running water.

**INACTIVE STORAGE** - water occupying inactive storage capacity of a reservoir.

**INACTIVE STORAGE CAPACITY** - the portion of live storage capacity from which water normally will not be withdrawn, in compliance with operating agreements.

**INSTALLED CAPACITY** - the total of the capacities as shown by the nameplates of similar kinds of apparatus such as generating units, turbines, synchronous condensers, transformers, or other equipment in a station or system.

**INTERCHANGE ENERGY** - electric energy received by one electric utility system usually in exchange for energy delivered to the other system at another time or place. Interchange energy is to be distinguished from a direct purchase or sale, although accumulated energy balances are sometimes settled for in cash.

**INTERRUPTIBLE LOAD** - electric power load which may be curtailed at the supplier's discretion, or in accordance with a contractual agreement.

**INTERRUPTIBLE POWER** - power made available under agreements which permit curtailment or cessation of delivery by the supplier.

**LINE LOSS** - energy loss and power loss on a transmission or distribution line.

**LIVE STORAGE** - water occupying live storage capacity of a reservoir.

**LIVE STORAGE CAPACITY** - the volume of a reservoir exclusive of dead and surcharge storage capacity.

**LOAD** - the amount of electric power delivered at a given point.

**LOAD FACTOR** - the ratio of the average load over a designated period to the peak-load occurring in that period.

**MANDATORY RULE CURVE** - same as Flood Control Rule Curve.

**MAXIMUM STREAMFLOW** - the maximum rate of flow at a given point during a specified period.

**MEDIAN STREAMFLOW** - the rate of flow at a given point for which there are equal numbers of greater and lesser flow occurrences during a specified period.

**MINIMUM STREAMFLOW** - the minimum rate of flow at a given point during a specified period.

**MODIFIED FLOW** - the observed or historical flow which has been adjusted to a common level of development by correcting for the effects of diversion demand including evaporation, return flow, and changes in storage of upstream reservoirs and lakes. As used in this report, a modified flow is corrected to a 1990 level of irrigation development, and is the flow available for power generation.

**NATURAL STREAMFLOW** - is the rate of flow at a given point of an uncontrolled stream, or streamflow adjusted to eliminate the effects of all man-made development.

**NET ENERGY FOR SYSTEM** - the electric energy requirements of a system, including losses, defined as: (1) net generation of the system, plus (2) energy received from others, less (3) energy delivered to other systems for resale.

**NONFIRM ENERGY** - electric energy having limited or no assured availability.

**NONFIRM POWER** - power which does not have assured availability to the customer to meet his load requirements.

**NORMAL** - the average value on an element over the fixed period 1961-90.

**OBSERVED STREAMFLOW** - is the amount of water that has been historically measured or otherwise determined to have occurred at a specified point in the stream system.

**ONE PERCENT ANNUAL CHANCE FLOOD** - a flood of a magnitude that has a one-percent chance of being equaled or exceeded in any given year; often referred to as the 100-year flood.

**OPERATING RULE CURVE** - a curve, or family of curves, indicating how a reservoir is to be operated under specific conditions to obtain best or predetermined results.

**OPERATING YEAR** - The period from August 1 through July 31 of the following calendar year. The operating year is the time base used in energy production. Prior to the operating year ending on July 31, 1991, the operating year had been defined as the period from July 1 through June 30 of the following calendar year. This revised definition is based upon an agreement between the signatories to the Pacific Northwest Coordinating Agreement (PNCA).

**OUTAGE** - the period during which a generating unit, transmission line, or other facility, is out of service.

**OVERLOAD CAPABILITY** - the maximum load that a machine, apparatus, or device can carry for a specified period of time under specified conditions when operating beyond its normal rating but within the limits of the manufacturer's guarantee, or in the case of expiration of the guarantee, within safe limits as determined by the owner.

**PEAK LOAD** - the maximum load in a stated period.

**PEAKING CAPABILITY** - maximum peak load that can be supplied by a generating unit, station, or system in a stated time period. It may be the maximum instantaneous load or the maximum average load over a designated interval of time.

**PEAKING CAPACITY** - generating equipment normally operated only during the hours of highest daily, weekly, or seasonal loads. Some generating equipment may be operated at certain times as peaking capacity and at other times to serve loads on a round-the-clock basis.

**PEAK LOAD PLANT** - a power plant which is normally operated to provide power during maximum load periods.

**PLANT FACTOR** - the ratio of the average load on the plant for the period of time considered to the aggregate rating of all the generating equipment installed in the plant.

**POTENTIAL HYDRO ENERGY** - the aggregate energy capable of being developed over a specified period by practicable use of the available streamflow and river gradient.

**POWER** - the time rate of transferring energy. NOTE: The term is frequently used in a broad sense, as a commodity of capacity and energy, having only general association with classic or scientific meaning (see also "Electric Power").

**POWER STORAGE** - that portion of the active storage, designated to be used for generating electric energy. Sometimes referred to as the power pool.

**PRIMARY ENERGY** - hydroelectric energy available from continuous power.

**PRIME POWER** - same as continuous power.

**PUMPED STORAGE PLANT** - a power plant using an arrangement whereby electric energy is generated for peak load use by using water pumped into a storage reservoir usually during off-peak periods. A pumped storage plant may also be used to provide reserve generating capacity.

**RECURRENCE INTERVAL** - the average interval in which a flood of a given size is equaled or exceeded as an annual maximum.

**REDD** - a type of fish-nesting area of a gravel streambed scoured out by salmonids for spawning.

**REFILL YEAR** - the period from August 1 through July 31 of the following year. The refill year is used in energy production studies.

**REGULATED STREAMFLOW** - the controlled rate of flow at a given point during a specified period resulting from an actual reservoir operation (observed streamflow below the project), or a theoretical operation.

**RESERVE GENERATING CAPACITY** - extra generating capacity available to meet unanticipated demands for power or to generate power in the event of loss of generation resulting from scheduled or unscheduled outages of regularly used generating capacity.

**RESERVOIR STORAGE** - the volume of water in a reservoir at a given time. Also Reservoir Contents.

**RESERVOIR CONTENT CAPACITY** - same as Reservoir Storage Capacity.

**RESERVOIR STORAGE CAPACITY** - the volume of a reservoir available to store water.

**RETURN FLOW** - that portion of the diversion demand that is returned to the stream system and is available for further downstream use.

**REVERSIBLE TURBINE** - a hydraulic turbine, normally installed in a pumped storage plant, which can be used alternately as a pump and prime mover.

**RUN-OF-RIVER PLANT** - a hydroelectric power plant using pondage or the flow of the stream as it occurs.

**SCHEDULED OUTAGE** - the shutdown of a generating unit, transmission line, or other facility, for inspection or maintenance, in accordance with an advance schedule.

**SEASONAL STORAGE** - water held over from the annual high-water season to the following low-water season.

**SECOND-FOOT DAY** - volume of water equal to one cubic foot per second flowing continuously for one day of 24 hours.

**SECONDARY ENERGY** - all hydroelectric energy other than primary energy.

**SECTION 7 PROJECTS** - those projects that qualify under Section 7 of the Flood Control Act approved 22 December 1944 (58 stat. 890; 33.U.S.C. 709). The Federal Power Act was approved 10 June 1920 (41 Stat. 1063; 16 U.S.C. 79(a)), and other references apply. See list in Appendix C.

**SMOLT** - an anadromous fish that is physiologically ready to undergo the transition from fresh water to salt water; age varies depending upon species and environmental conditions.

**SPAWNING** - the laying of eggs, especially by fish.

**SPILL** - the discharge of water through gates, spillways, or conduits which bypass the turbines of a hydroplant.

**STAGE** - the height of the water surface in a river or body of water measured above an arbitrary datum, usually at or near the river bottom. Measurements of reservoirs are generally measured above sea level.

**STANDARD PROJECT FLOOD** - a very large (low frequency) design flood standard applied to the design of major flood control structures and representing the most severe combination of meteorological and hydrological conditions considered reasonably characteristic of a particular region.

**STORAGE CAPACITY** - same as Reservoir Storage Capacity.

**STREAMFLOW** - the rate at which water passes a given point in a stream usually expressed in cubic feet per second.

**STREAMFLOW DEPLETION** - that portion of diversion demand that is permanently removed from the stream system.

**SURCHARGE STORAGE CAPACITY** - the volume of a reservoir between the crest of an uncontrolled spillway, or the volume between the normal full pool elevation with the crest gates in the normal closed position, and the maximum water surface elevation for which the dam is designed.



**SURPLUS CAPACITY** - the difference between assured system capacity and the system peak load for a specified period.

**SURPLUS ENERGY** - generally energy generated that is beyond the immediate needs of the producing system. Specifically for BPA, electric energy generated at Pacific Northwest hydroelectric projects of the Government which would otherwise be wasted because of the lack of a market therefor at any established rate. This energy is frequently sold on an interruptible basis.

**TAILWATER** - that portion of a river or water body immediately downstream of a dam or powerhouse.

**TULE** - a fall chinook salmon that spawn in the lower Columbia River that enters the river system in the spawning metamorphosis state and has already lost its shiny silver color.

**UNREGULATED STREAMFLOW** - regulated stream-flow adjusted to eliminate the effects of reservoir regulation, but reflecting the effects of natural storage in lakes and river channels.

**UPPER RULE CURVE (URC)** - same as Flood Control Rule Curve.

**VALLEY STORAGE** - the natural storage capacity in a given reach of a stream both within and without the banks. It varies with the position of the water surface.

**VARIABLE ENERGY CONTENT CURVE (VECC)** - determined for certain large reservoirs which do not have all storage drafted to normal bottom elevation by Base Energy Content Curves. The Variable Energy Content Curves provide 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, minimum discharge requirements, non-owner requirements for water at-site and upstream, and water required to refill upstream reservoirs. The inflow volume at each reservoir may be reduced by deducting the 95% confidence forecast error, power discharge requirement, non-power requirements upstream (if any), and water required for refill at upstream reservoirs.

The rights, obligations and limitations are the same as those defined by the Energy Content Curve.

**VARIABLE REFILL CURVE (VRC)** - is the elevation needed to refill a reservoir with 95 percent assurance based on the current runoff forecast.

**WATER BUDGET** - a specific volume of water set aside in reservoirs to be released in a manner and at a time to provide benefit to the migration of salmonids.

**WATER YEAR** - The period from October 1 through September 30 of the following calendar year. It is the time base used in hydrology.

**WILD FISH** - fish that are spawned and reared in natural redds, as opposed to hatchery produced stock.