Selective Withdrawal from Man-Made Lakes

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Effective planning, design, management, and operation of one or more man-made lakes for optimum conservation and use of regional water and related resources for many purposes involves, among others, the problems of predicting, monitoring, and controlling the thermal and chemical quality of impounded water and releases through spillways, powerhouses, and outlet works. An evaluation of the effectiveness of various structures in selectively withdrawing releases from various levels of stratified reservoirs is urgently needed for multipurpose projects that have specific thermal and chemical release requirements for existing and future needs.

The desire to release quality water requires monitoring the characteristics of reservoir water and knowing the flow pattern to be expected in the immediate and upstream vicinity of various regulating structures. Therefore a determination of the effect on withdrawal of the size, shape, and spacing of multilevel openings is desired to permit prediction and control of the stratum of the reservoir from which releases are made and selection of effective locations for fixed monitoring stations. An evaluation of the effectiveness of submerged skimming weirs and walls or thermal barriers in preventing the intrusion of either cold or warm water into powerhouse intakes and single-level outlet works is also of primary concern.

During 1966 the U.S. Army Corps of Engineers initiated laboratory research at the Waterways Experiment Station to determine the characteristics of withdrawal zones resulting from release of flows from randomly stratified reservoirs through orifices and over weirs for developing means of predicting and controlling the quality of water discharged through various regulating structures. Stratification was generated in experimental facilities by means of differentials in both temperature and dissolved salt concentration. Density distributions were determined from temperatures and salinities measured with thermistors and conductivity probes. Velocity distributions were obtained by dropping dye particles into the flow and photographing the resulting streaks with movie cameras.

Generalized expressions describing the limits of the withdrawal zone and the distribution of velocities therein were developed from analyses of the velocity and density distribution data. Means for evaluating those conditions where the free surface and/or bottom boundary dictate the upper and/or lower limits of the withdrawal zone were also determined. Since the velocity distribution to be anticipated for any given density distribution upstream of an orifice or weir can be predicted, the weighted average technique can be applied to predict the value of any water quality parameter of the outflow for which a profile in the reservoir is known. (This paper is a summary of material presented by *Bohan and Grace* [1969, 1973] and *Grace* [1971].)

REFERENCES

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