THE CORPS OF ENGINEERS AND WATER QUALITY CONTROL

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The Corps of Engineers, through the development of water resource programs throughout the Nation, has provided water quality control for a number of years. This has taken the form of low flow augmentation and stream flow regulation. In order to prevent the degradation of a stream to a point where it no longer is of value for any purpose for other use downstream, careful consideration must be given to its flow characteristics and its ability to recover through natural processes. Numerous factors enter into this recovery capability, but one of the prime factors is considered to be the quantity of flow available at all times.

If Mother Nature were cooperative enough to provide even distribution of stream flows throughout each year there is little doubt that adequate waste disposal systems, of economic feasibility, could be provided to provide high-quality, valuable waters to users downstream of the effluent discharges. Unfortunately, this is not the case. An increase in minimum flows, that is to say, Low Flow Augmentation, becomes an extremely important and valuable factor in the control of water quality.

REQUIREMENTS OF SUPPLEMENTAL FLOWS

Since 1961, all Federal agencies engaged in the development of water resources have been directed to give consideration to inclusion of storage for regulation of streamflow for the purpose of water quality control during the survey and planning of reservoirs. The need for and the value of providing storage in multi-purpose impoundments is determined through joint efforts between the design and construction agency and the recently created Federal Water Pollution Control Agency and the State and local agencies affected.

Needs for streamflow regulation for water quality control necessitates consideration of volume, time, location, and quality aspects of streamflow requirements, and examination of possibilities for streamflow regulation for all uses. The stream quality standards and objectives must be created for each specific project in order to appraise the needs for streamflow regulation.

The relative significance and amounts of on-stream and off-stream

uses, and the availability, desirability, relative dependability, and cost of treatment of raw water supplies in the case of off-stream uses have important bearing on the determination of needs and the selection of stream quality objectives.

Cost is an important factor in isolation of stream quality objectives. For example, treatment of water to meet specialized industrial use requirements might be far less costly, and perhaps more dependable, than achieving the desired level of quality in the raw water supply. If stream quality objectives are selected without care in such cases, the ultimate over-all cost of achieving desired water quality at the point of use may be increased without any compensating gain in effectiveness of water use. The general magnitude of the cost necessary to achieve selected stream quality objectives must be compared with cost experience in similar situations to give some indication of the likelihood of public acceptance. In cases of doubt, several levels of stream quality objectives should be considered so that the added cost of achieving progressively higher stream quality may be available as a guide to judgment. Different stream quality objectives may apply to different stream reaches, depending on the demands which will be placed upon them.

VALUE OF SUPPLEMENTAL FLOWS

The value of water quality control lies in its contribution to safety and effectiveness in the use and enjoyment of water. Economic, aesthetic, and social considerations are involved in this concept of value. Measurement problems are difficult. Where adequate, direct waste control programs have been undertaken or have general public acceptance it may be reasoned that a public value judgment has been made that the level of water quality control attainable from such programs is worth at least as much as the cost of its attainment. In general, this sort of value judgment is considered to apply at least through the range of adequate direct waste control. However, it does not follow that direct waste control cost may be extrapolated at will as a measure of the value of additional levels of water quality control.

The initial step in evaluating the water quality control benefits attainable from streamflow regulation is to identify, and insofar as possible quantify, the adverse results of failure to provide such supplementary control. These may include such damages as preclusion of additional economic development, corrosion of fixed and floating plant, loss or downgrading of recreational opportunities, increased municipal and industrial water treatment costs, loss of industrial and agricultural production, impairment of health and welfare, damage to fish and wildlife, and degradation of the aesthetics of enjoyment of unpolluted streams. Damages such as these may be composited roughly into tangible and intangible categories, and their reduction used as a measure of the value of corrective action. However, care must be taken to recognize possible duplications and limiting values which, if observed, might result in false conclusions concerning justified levels of expenditure for corrective action such as streamflow regulation. For example, if the cost of corrective water treatment necessary to avoid loss of in-

dustrial production would be less costly than corrective water treatment, the amount of loss would comprise a limit on the benefit creditable to alternative corrective streamflow regulation.

The second step in evaluation is the determination of the benefits derived from providing a range of supplementary flows. This varying range is required before an accurate quantitative and qualitative conclusion can be made. Evaluation of benefits derived from flow augmentation presents many thought provoking problems. Much has been learned in the past regarding determination of benefits, but the lack of background data and the increasing complexities of evaluation makes it mandatory that much effort be expended in development of criteria and standards for use in benefit derivation.

The techniques for evaluation of flow regulation benefits for navigation, hydro-power generation, flood control and irrigation have been fairly well established. The evaluation of flow regulation from a water quality standpoint becomes more complicated. Many types of effects become pertinent in these determinations. Literally thousands of compounds are introduced into the streams, some simple and others more complex. The improved quality of domestic and industrial supplies; improvement of fish and wildlife habitat and sport or commercial fishing; reduced costs of domestic and industrial waste treatment facilities; temperature reduction; oxygen increase; increase in potential industrial plant expansion; improved recreational potential; all are but a portion of the many factors which must be evaluated. Highly qualified personnel in practically every area are required to work closely together in order to establish the methods and parameters involved in evaluation of net benefits.

REALIZING RESULTS

So far this discussion has dealt with the definition of Low Flow Augmentation, its application, its benefits and the need for additional knowledge and research. All of the planning, investigation and studies conceivable are of no value whatsoever, if no positive action is taken to physically construct facilities for the purpose of water quality control through flow supplements.

Results have already been realized from the studies and planning of various multi-purpose projects. The Mobile District has a project under construction at the present time in which storage capacity for the purpose of water quality control has been provided. The Okatibbee Dam above Meridian, Mississippi, has an allocated capacity of approximately 21,000 acre feet for water quality control. Releases for water quality control will be made in sufficient quantity to supplement the local inflows downstream, so that stream flows are adequate for the assimilation of wastes and to insure maintenance of a good quality water. The rates of flow necessary to insure maintenance of quality were predetermined in cooperation with the Public Health Service. These minimum flows will be maintained regardless of pool elevation, until the minimum storage level is reached. In the case of an unusually prolonged drought period, water will be released for water quality control at the discretion of the District Engineer.

Current planning of tentative projects in Mobile District area at present indicates a need for storage of water for quality control in some projects. Studies being made at present of the Pascagoula River Basin definitely indicate a need for low flow augmentation. With adequate treatment of domestic and industrial wastes, regulated releases from allocated storage in multi-purpose reservoirs will be able to maintain the quality of the streams at recommended levels.

OTHER AREAS

Low flow augmentation is not the only part being played by the Mobile District in the quality control and improvement in water resources. Currently, some studies are being carried out and others are being planned to determine the quality of water being released from Corps of Engineers projects. The primary objective of this present program is to obtain information needed to indicate causes of and solutions to water quality problems associated with the operations of existing projects. The program includes instrumentation for measurement of selected physical and chemical properties of the waters and investigations into the biological and limnological aspects of impoundments and water being released. The evaluations are expected to indicate the interrelated influences of inflows, impoundments and outflows on the quality of water. Beneficial as well as adverse effects of reservoir storage and releases are to be evaluated. Ultimately the results of the continued investigations are expected to add to the general knowledge necessary for improvement of capabilities in project planning, design, and operation for optimum control of water quality.

Some investigations and studies underway are as follows: At Buford Reservoir in Georgia, equipment is being installed to automatically monitor and record D.O., temperatures, conductivity, pH and turbidity downstream from the powerhouse. Field observations of D.O., iron, manganese, pH and temperature have been made in the reservoir and at several downstream points during the fall of 1965. Additional field observations will be made as needed to supplement the study evaluations.

At Walter F. George Reservoir near Fort Gaines, Georgia, automatic equipment is in operation monitoring D.O. and temperatures. It is planned to install additional equipment to measure pH, conductivity and turbidity. In addition, a cooperative program of limnological studies is underway for the second year with the State game and fish agencies of Alabama and Georgia and Auburn University. These studies include field observations of D.O., temperature and carbon dioxide in the reservoir and for several miles below the dam and a continuing creel census to evaluate the effect of reservoir operation on fishing. Additional studies will be made to further determine the biological and limnological aspects of this project.

At Allatoona Reservoir in Georgia, field observations of D.O., iron manganese, pH and temperature were made in the reservoir and at several downstream points during the past two years. Observations were made at two-week intervals and continued through the critical season until the fall turnover. The purpose of these studies at Allatoona are to:

a. Determine the reaeration characteristics of the Etowah River.

b. Determine the related hydrodynamic mixing parameters.
c. Investigate the effect of the power wave on downstream water quality parameters.

As new multi-power projects are constructed, water quality monitoring equipment will be installed, such as at Claiborne, Millers Ferry and Jones Bluff.

SUMMARY

In conclusion, the significance of water quality control through low flow augmentation is rapidly moving towards being one of the more important factors in the development of water resource projects. It appears that this approach to stream improvement may well become the controlling requirement for reservoir storage in many areas. It should be clearly understood, however, that the provision of storage for this purpose is not a substitute for adequate treatment methods. Low flow augmentation can be provided only after assurance that the best available methods and procedures are being used to reduce the amount of pollutants to the highest degree economically feasible.

In the Corps of Engineers' programs, we are investigating the possibilities for changes in design of our dams to optimize the temperature and oxygen content of water released in the downstream channels, or to provide multiple-outlets to permit discharge of water from various selected levels in the reservoir. We are, in appropriate cases, monitoring the water at various depths in our reservoirs, and in the released waters. We are searching all avenues for information that will improve our ability to evaluate flow regulation effects and those that will lead to more effective design of project features to accomplish beneficial control of water quality.

The Corps of Engineers is pledged in all its activities to the abatement of pollution and to the maintenance and improvement of water quality as well as meeting other needs in the development and use of the Nation's water resources.