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CONSERVATION OF THE QUALITY OF WATER OF NEW YORK STATE AS A NATURAL RESOURCE

ECONOMIC VALUE OF QUALITY IN WATER

THE original abundance of water in the state of New York, its very commonness, has dulled her people's appreciation of the subtle quality value of their heritage. Momentarily shut off from their supply the cities and industries would instantly realize its vital necessity. Precipitate ruin of the wonderfully rich, living waters of the state would awaken immediate appreciation of their unreplaceable benefits. Coincident with the decreasing quality condition of the waters, grows its greater economic value. The expansion of cities with their manufactures and commerce is dependent on the very water which they threaten, and the wealth flowing from them seeks the natural wealth of the streams, and the food driven from their waters. Consider the millions spent in carrying pure water long distances to the cities, in protection of the watersheds, building and operating filtration plants, and in the disposal of sewage. Consider the millions dependent on clean water at the recreational resorts of the people. Consider the value to manufactures themselves of obtaining water of the proper quality for their processes. Consider the value of fish as unrivaled sport and unreplaceable food, and the value of shellfish industries to the state. Consider, lastly, the expense to the state in guarding these resources and in hatcheries to correct the failure of the waters. Not only may the people be denied the recreational advantages of clean waters, and the return from industries dependent on them, but they must bear the extra burden of obtaining suitable water for their vital necessities. Considering the magnitude of its trust, the state can afford to conserve its interests in the quality of water by using it to her greatest advantage.

NEW PROBLEM

The increased quantity of domestic wastes resulting from the natural growth of population does not account for the rapid deterioration in the quality of the natural waters of New York state. Sewage pollution has been anticipated; it is a time-honored problem of gradual growth; methods of treatment have been developed, and in general it is cared for by municipal disposal plants. Trade wastes, however, from the recent astonishing development of chemical industries, unnaturally supplemented by war demands, have given rise to another and more complex problem. New manufacturing plants have been built along the water courses, and the activity of older ones extended and enlarged. Little time has been left for contemplation of the damage caused by their wastes, or of preventive methods, and, unless immediate measures are taken, a great resource of the commonwealth is threatened.

QUALITY CAPACITY LIMITED

To those who have measured the amount of water with which nature endows a given area, it is obvious that the quantity is limited. Though not so concrete or commonly understood as its quantitative capacity, as for navigations and for the development of water power, its qualitative capacity for these other purposes is no less limited. The amount of contaminating material a water can absorb without injury to its various uses is strictly limited by the rate at which such substance may undergo physical or chemical change; in no other way can water escape the qualitative result of its use. This in turn depends upon the biological capacity of a stream to bring about those changes, and in this sense the waters are alive. Anything which upsets the digestive power of a stream further incapacitates it for discharging its natural functions, until such time as it may recover by increased dilution. There is a strong temptation for users of the water to ignore that fact, because the carrying power of the stream removes the offence from its source, and the natural limits are usually far exceeded before remedial action is considered. Just as in the case of development for water power, the qualitative limits of its natural capacity to be of economic value can be expanded by judicious use and scientific development.

PROPER UTILIZATION

Sufficient knowledge of the principal properties of water will enable the state to most fully utilize its proper value. It does not follow that individuals, communities, or industries, cease to return used waters to their natural drainage channels; nor is it possible by any treatment to return them unchanged. It is clearly recognized that water has a considerable dilution value within which ultimate harm is not done, and that the natural disposal capacity is one of its most fundamental and valuable assets to the state. By this is not meant the ability to carry waste away from one place to afflict another, but a truly legitimate purification function. As such it plays a great part in the economy of nature. There is constantly going on a process of regeneration of inorganic substances to organic, recharging them by the action of sunlight on green plants with the energy necessary in food for the vitality of man and other animals. From the unoxidized organic wastes of our activity must these inorganic salts be reclaimed. Nature has chosen the bacteria and other lower organisms as agents for this purpose. It is for them to prepare the nitrogen and other elements in those wastes for the next crop of vegetation. If they cease to work, these wastes would accumulate unchanged, clog the progress of the organic cycle in nature, and in a short time the earth would become a desert waste. While this activity is not restricted to the water, it particularly concerns America, whose universal adoption of the water system of sewage disposal loses a valuable fertilizer from its natural place on the land. By enriching the vegetation in the waters and furnishing abundant life thereto, it may be again returned to the people as fish and shellfish instead of beef and mutton. Such a broad consideration of conservation may not seem of immediate con-

cern in the practical use of the waters until it is realized that the same activity gives to water its disposal capacity. Without it, waste matters accumulating from the sources would render the stream unusable below. By the suitable adjustment of all factors, therefore, can its greatest benefits be derived. Only under the most exceptional circumstances are we justified in sacrificing all other uses merely to the carrying capacity of the fluid. By jealously guarding its quality and developing its useful capacity the increased burden from communities and industries can be prepared for.

INJURIES TO QUALITY VALUE

The various ways in which the quality value of water may be injured are as diverse as its many uses. Potability, where essential for public water supply, takes precedence over all other uses, and infection becomes the most dangerous injury to water. Though industrial waste seldom in itself carries infection it may in other ways by giving disagreeable odors, unpalatable taste, or objectionable color and appearance, render it unfit for drinking purposes. Furthermore, it may render purification difficult, thereby overload filtration the health of the community rests; or it may so hinder the proper functioning of sewage disposal plants as to place such a burden on the stream as to make it an impossible supply for the community. Less important, but more obvious, it is necessary for each industry to have an abundant supply of water relatively free from particular substances. For wool scouring it is lime salts; for the manufacture of fine paper it is discoloring material; and so with each industry there are some substances to be avoided. This often determines the location of an industry, and though it may be possible to treat the water in many instances, preventive measures where small concentrations entail widespread injury may be the simpler and cheaper method. There are changes in the water such as to render it unfit for boating, swimming and other recreational purposes. These effects are readily appreciated by the public, who should be anxious to support action where a public attraction becomes an open offense to public decency because some private interest wishes to monopolize a great asset for the smallest use. An enterprise which does not compensate the state for its injured interests is a deficit, and it should be the duty of conservation to prevent a selfish theft.

EFFECT ON FISH LIFE

The Conservation Commission already has been intrusted with the enforcement of laws to prevent the introduction of deleterious substances in quantities injurious to fish life. Such effect is evident where acids or poisonous wastes kill adult fish, or foreign substance may render shellfish unattractive to the consuming market. If the oxygen dissolved in the water becomes greatly diminished the fish will suffocate. Water is to fish what the ground and air combined are to land animals; it furnishes the oxygen for respiration as well as the food they eat. Organic wastes have the power to absorb the oxygen from the water and make it uninhabitable for fish life. Such an oxygen demand can be readily determined and its effect on the stream studied and predicted. Similarly those wastes which hurt the production of fish food indirectly eliminate fish from the water and its absence can not be attributed to overfishing; and anything which drives away the fish has the same effect as removing them in other ways.

Less evident, but equally important is the effect upon the development of the young, the ruin of hatching areas, and the death of the fry which may bring the efforts of the hatcheries to naught. Even though the areas of excessive pollution are localized to greater or less extent they may form pollution dams which interrupt the normal habits necessary to fish propogation. It may be possible to define the quality requirements of different areas in such a way that by artificial assistance each may be used for what it is particularly adapted, to the ultimate improvement of the whole, at the same time giving greater latitude for use of the industries.

LIMITING FACTORS

The injuries enumerated are tangible values which the water may lose. There is, however, the general value of the life in water which is so essential to its preservation for all the various uses. This life constitutes a great biologic equilibrium, delicately balancing a very complex system of factors each dependent upon the other. At any particular time a certain very small factor may determine the condition of the water. The knowledge of what biologists call limiting factors holds the greatest constructive possibilities. If this fundamental principle is thoroughly grasped, it makes evident the great significance of certain wastes under particular conditions, where a limiting factor may be involved, and it shows also the possibility to save a grave situation sometimes by a simple expedient. The most important study in the conservation of the quality of water is thus to determine the specific effect of various contaminating substances upon the limiting factors controlling the biologic equilibrium, and by eliminating them to expand the useful capacity of the streams.

PREVENTIVE METHODS

The scientific problems involved in the treatment of domestic sewage by municipalities have been largely solved. Methods are available for the intensive biologic oxidation of the organic matter so that the subsequent oxygen demand on the stream may be reduced to any prescribed requirements. The same principles may be developed for the treatment of other organic wastes from food producing industries, so that there should be no excuse for the depletion of that great essential constituent of the water. Considerable improvement can be accomplished in many cases by simple changes at little cost. Damage often occurs through thoughtlessness or carelessness, or is due to avoidable accidents. Where the attention of manufacturers has been brought to the serious consequences of such hazard they have been willing to take proper precautions and construct sufficient safety devices. The increased utilization of valuable by-products, by methods well known to industry, has gone far to remove the greatest wastes. Likewise there are corrective processes for settling out or straining out suspended matter, preventing or removing colors, tastes, odors, oil films, etc., and chemical methods for removing or rendering inocuous such deleterious dissolved substances as may work injury to the water. By the conservative application of such methods the improvement necessary to meet specified conditions can usually be attained, if not always with profit, at least without unreasonable hardship.

RESPONSIBILITY OF INDUSTRIES

The responsibility lies with the industries, who receive from the state the benefits from the waters, to study and apply the methods of treatment of their injurious wastes. This has been done in the past because of the value of many of the by-products, and in several of the more progressive concerns laboratories are constantly engaged in reclamation studies. While the possibility of returns has inspired most of these investigations, the knowledge gained leads the way to processes for the protection of the waters, and, in many cases, industries have already realized their responsibilities to the extent of adopting measures for this purpose. The great diversity and complexity of these processes make it impossible, with the limited forces at its disposal, for the state to study each individually, while the extensive chemical facilities of the plants themselves make them not only the responsible, but the logical, places to carry out much of the work. Thus will the scientific knowledge that created the damage also assume the burden of the solution of the problem of its prevention. The federal government is engaged in the study of some of the broader problems of national scope and some states have applied themselves to the solution of certain wastes in which they are particularly concerned. Where the benefits to the state justify the expense, it should be a legitimate function to study the problems which will be of general application to many industries. On the other hand, the generality of the prob-

lem of the effect of wastes upon the waters makes it a peculiarly appropriate field of study for the state and for the authority who should be the responsible judge of the requirements and standards which should apply.

POLICY OF THE COMMISSION

The Conservation Commission desires to take the broadest possible constructive attitude in approaching the problem of maintaining and developing the quality value of the water. Its relations do not bind it to any particular interest or phase of the subject to the exclusion of the others. It can avail itself of the results of the many activities working separately towards conservation of some particular quality value and, by coordinating such activities, temper their demands and supplementing them with a knowledge of changes in the water itself, develop its uses for the greatest benefit of all. The decision on all questions depends upon the particular condition and use of the water and the Commission should be able to avail itself of the best expert knowledge and testimony for sound judgment. In certain phases it will be necessary to establish new standards between those of drinking water requirements and those of common decency. That its rulings and regulations may be fair and trustworthy considerable information must be gathered and investigations prosecuted into the necessity of the measures taken. That the burden on industry or the state may be lessened, discoveries must be gleaned into the unknown possibilities of scientific development. Where prohibitive expense will be required to overcome a natural obstacle which can better be accomplished artificially by fish hatcheries or otherwise, there must the knowledge be available for the conservation of such a resource. In general, therefore, should the state interest itself in and take the action required for the development of scientific *aquiculture* that it may utilize the great water quality resources of the state.

COOPERATION WITH INDUSTRY

It should be evident that the most successful fulfillment of such a program can only be accomplished by active cooperation with the industries. The Commission welcomes, therefore, all opportunities to establish such cordial relations. It aims to become a clearing house for all available information bearing on the common problem. By associating itself with other agencies, in this and other states and the federal government working on the quality of water it can acquire the knowledge obtained by all. It will collect, classify and file for the use of all such methods and data as it may accumulate or discover. Its own investigations will aim to discover the limiting factors which operate to restrict the use of the waters, that corrective measures may be direct and economical. It will publish from time to time such information as may seem of use to the industries as well as to the public. It invites conferences, suggestions and data. In particular is it anxious to assist to the limit of its power the investigations of the industries themselves. At the present time funds are hardly adequate to carry out necessary investigations on the water, but the technical forces will be glad to consult and give any suggestions possible in carrying out such studies.

ASSISTANCE FROM INDUSTRIES

The industries, on the other hand, are in a position to render much honest assistance to the commission in the prosecution of its work. Because of limited funds it will not be possible to carry on its studies on the extensive scale which the magnitude of the problem warrants. The facilities of the various industries would help greatly to attack these problems in earnest, and the working data in their hands will greatly augment the value of the studies.

IMPORTANCE OF TECHNICAL KNOWLEDGE

The industries should be quick to appreciate the necessity of sound technical information. The efficiency upon which their dividends depend is of equal value in exploiting the resources of the water. Waste of its possibilities represents the greatest loss of all. Economy of its value depends upon elimination of what may be discovered to be unnecessary steps or in

the substitution of cheaper or more effective methods. Unintelligent operation is truly false economy, and legislation should not be left to popular caprice, but be tempered and directed by sound scientific knowledge. Especially in such a delicately balanced operation as the scientific control of the natural waters is it necessary to know the facts. Where a small factor can determine the whole condition it is necessary to be familiar with all the details. If a limiting factor can be removed by a simple expedient it allows for expansion all along the line until the next lower factor replaces it. Perhaps this, in turn, may be eliminated with slight treatment, and by successive steps in biological technology can the capacity of the stream be greatly increased with the least expenditure of effort and money.

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PLEISTOCENE CLAYS AS A CHRONOMETER

The Swedish expedition now in America, led by Gerard DeGeer, has an ambitious program of proposed discovery. Following are quotations from his announcement:

. . . the undersigned described how he had, since 1878, worked out and utilized a method of determining by actual counting of certain seasonally distinct laminated clay layers, the chronology of the past 12,000 years, or the period that witnessed the evolution of man as well as of the whole fauna and flora of those parts of northern Europe and North America which during the Ice Age were barren deserts covered by extensive ice sheets, ...

By the new method of investigation it has now been shown to be possible to follow, step by step, how the large ice sheets receded and melted away, this being registered from the melting season of every year by the annual deposition of melting-water sediment, and especially of seasonally laminated clays.

The annual lamina from warmed years being thicker and from colder ones thinner, the chronological self-registering is at the same time a thermographical one. . . .

It will thereby no doubt be possible by a kind of primary triangulation to fix at a sufficient number of points the very years when they passed by the receding ice border. By interpolation between the figures thus obtained and by help of the already mapped moraine-lines, now to be accurately dated, the laws regulating the whole recession of the great ice-sheet can certainly be established and at the same time the rate by which the rideau was pulled away from the stage of life and the amount of time during which in every region of the northern part of the New World the plants and animals have had at their disposal for their immigration and settlement; the time required for the development of the soil and the vegetable mould, for the rivers and the lakes for their erosional work, and for the evolution of our prehistoric ancestor.

. . . . . .

Still, the most far reaching result of the whole investigation might be that so rapid and at the same time so widely distributed variations of the temperature of the air scarcely can be attributed to any other cause than variations in the amount of heat reaching the earth from the sun. . . .

If that program should be promptly carried out the pleasure from scientific discovery by future students will be reduced. Truly, a yardstick of geologic time is greatly desired. More desired than needed. We know that time is long, but how long? The most common question to the geologist is "how long ago?" But if we knew the exact number of years since the ice sheet disappeared from New York, whether 31,676 or 109,322 years it might satisfy some curiosity but would make little difference in human life and race evolution. For we know that geologic time is not to be measured by human standards, and when we deal in millions of years the number of the millions has little significance. The subject appeals to the imagination, especially of the non-geologic public, and if Mr. DeGeer can find out even a part of his program he will make interesting discovery and we applaud the effort. However, lest the public should be too greatly disappointed, it is well to realize some of the difficulties in the study.

The laminated glacial clays which are the subject of measurement were deposited in deep or quiet waters facing the receding front of