Limitations on the Recreational Use of Domestic Water Reservoirs

CHARLES E. SMITH, M.D., D.P.H., and HENRY J. ONGERTH, B.S., M.P.H.

IN the public health sense, impounding reservoirs may be considered as falling into two general classes, those developed primarily for domestic water supply and those serving a whole spectrum of multipurpose uses. This paper applies only to reservoirs developed primarily for domestic water supply. In California these reservoirs are relatively few in number and represent only a small percentage of the total surface area of fresh water lakes in the State. However, their accessibility makes them especially convenient for recreational use.

In California, there is a conflict of interest in proposed recreational uses of domestic water supply reservoirs. Pressures of increasing population and increasing need for the limited water resources of the State result in an ever-growing appreciation that there must be maximum, and therefore multiple, use of our water resources. This multiple use may include recreational activities. People have more leisure time with more need for recreation than in the past, and, as cities grow larger, there is less and less room for this recreation. For these reasons people interested in recreation desire to use all possible reservoirs and watersheds. The California State Board of Public Health officially expressed its position with respect to such use in a resolution which it adopted in 1955:

"The State Board of Health recognizes its responsibility for promoting the total health of the people of California and is cognizant of the beneficial role of adequate recreational facilities in the promotion of health. The board recognizes that in certain situations recreational use of water supplies under proper restrictions is feasible."

However, there is universal agreement that any possible damage to public health in the use of domestic water supply reservoirs must be prevented.

The California State Board of Public Health and the California State Department of Public Health neither compel nor prohibit the recreational use of domestic water supply reservoirs. Their stand is that this option is a local responsibility. In turn, the State's responsibility is to evaluate proposals for recreational use and to determine whether they provide sufficient safeguards to protect the public health.

There are two important factors to consider in this public health problem—hazards of disease transmission and esthetic considerations.

Transmission of Disease

We have considerable knowledge concerning risk of disease transmission, although it is admittedly incomplete. So far as we know, the

Dr. Smith is dean of the School of Public Health, University of California, Berkeley, and president of the California State Board of Public Health. Mr. Ongerth is a sanitary engineer and head of the water supply section of the California State Department of Public Health, Berkeley.

This paper was presented at the Conference on Recreational Use of Impounded Water held in Richmond, Calif., December 13–14, 1956, under the auspices of the department of conferences and special activities, University Extension, University of California.

major disease potential in recreational use of water supply reservoirs is from improper disposal of human wastes, especially the feces, of those using the reservoir and watershed area. The inability to control all wastes leaves a potential hazard of some disease transmission.

Experience with water supply reservoirs in California now used for recreation has demonstrated that absolute control of human wastes has never been achieved. If control is lax, feces may be deposited directly in the water or on watershed lands. The hazard from the deposition of feces on land is obvious: falling rains and surface runoff will carry the material into the reservoir, pathogenic organisms may travel to the point of water intake from the reservoir, and, unless they are destroyed or removed by treatment, they may ultimately flow to the consumer.

When conditions exist which permit fecal discharges to enter raw water, it is important to know the fate of the pathogenic organisms. Using *Salmonella typhosa* as an example, the literature related to its survival in feces, soil, and water is of interest. Various conflicting reports have been summarized by Rudolfs and his coworkers from Rutgers University (*1*). From their summary, two things are clear: The bacteria may survive for periods as long as 100 days in feces or on soil, and the bacteria survive longer in pure water than in polluted water. This second observation is of critical importance to the waterworks industry, as pointed out by Taylor (*2*), who wrote: "Pollution of pure or purified waters at waterworks, in service reservoirs, or in mains is thus particularly dangerous, and the most stringent precautions are necessary to protect water prepared for delivery to consumers."

The clean water of many domestic water supply reservoirs and of all distribution reservoirs provides minimal biological competition for pathogenic micro-organisms which may contaminate it. Therefore, the opportunities for survival of pathogens are greater. On the other hand, in large impounding reservoirs and natural lakes, the factors of time, dilution, and sedimentation can enable recreational use of water without compromising the quality of the water as withdrawn for treatment. Water supply intakes must be protected by establishing a closed area around them to prevent direct introduction of contaminating materials. Furthermore, care must be given to the location and design of the intake works to take advantage of the factors of time, dilution, and sedimentation.

Appropriate treatment must be provided for all surface water to guard against any pathogens which may elude the natural barriers. Fortunately, *S. typhosa*, and other pathogenic bacteria, are removable from water and are destructible. Investigations and experience have shown that complete water treatment, which includes filtration and postchlorination, can produce a satisfactory finished water from a contaminated raw water. However, we would stress that public health authorities have agreed that there must be bacterial limits for "raw" water whether receiving only chlorination or complete treatment. These limits are expressed in terms of the numbers of coliform bacteria which must not be exceeded if safe water is to be produced by treatment.

While it is agreed that, if not "loaded" too heavily, complete water treatment is adequate to produce a water free from bacteria which cause typhoid fever or other enteric diseases, the problem with respect to some parasites and viruses is not equally simple. Among the parasites we may mention *Endamoeba histolytica*, which causes amebic dysentery. Although amebic cysts normally are removed by filters they are difficult to destroy by chlorine when this is the only treatment employed.

The viruses present another challenge to water safety. Filtration is much less effective in removing viruses than in removing bacteria or parasites (*3*, *4*). While poliomyelitis virus is usually spread by contact between infected and uninfected individuals, it is often present in the feces of healthy persons and has frequently been recovered from sewage. Fortunately, free residual chlorine rapidly inactivates it. The Coxsackie viruses also have been demonstrated in urban sewage. Most Coxsackie viruses do not cause disease, though one epidemic occurred in California during 1956. Like the typhoid bacillus, Coxsackie viruses have been shown to survive longer in unpolluted than in polluted water. They have survived as long as 47 days in river water. While chlorine will inactivate these viruses, from 7 to 46 times

more chlorine is required for killing Coxsackie viruses than for killing *Escherichia coli.*

The newly recognized enteric cytopathic human orphan (ECHO) viruses also are excreted in feces. The role of these viruses in causation of diseases and their manner of spreading disease are as yet undefined although some appear to cause aseptic meningitis which may be confused with poliomyelitis.

Admittedly, poliomyelitis, Coxsackie, and ECHO viruses have never been proved to have produced waterborne epidemics and thus may only be theoretical hazards in water supplies. However, the virus causing infectious hepatitis is known to have caused waterborne outbreaks. The virus of this debilitating disease may badly damage the liver, frequently producing marked and severe constitutional symptoms with prolonged convalescence. The virus never has been cultivated nor have laboratory animals been found to be susceptible so data on its survival are not available. In the massive waterborne epidemic at New Delhi, India, in spite of the presence of a good treatment plant, 10,000 cases of hepatitis occurred.

We must recognize that the public's expectation of perfect performance of water treatment plants may be unduly optimistic. Man may err and equipment may fail. Even though water treatment facilities are provided, safeguards, care, and judgment must be exercised to insure that the capabilities of the installed facilities are not exceeded. We cannot accept the philosophy that it is unnecessary to concern ourselves with the quality of raw water, that all we need to do is spend enough for water treatment facilities to produce a safe and acceptable water.

In milk sanitation, major reliance for protection of milk supplies is placed on pasteurization, but the whole milkshed must provide barriers to contamination. Cows must be guarded against disease and the milk against dirt, manure, and human contamination. The final safeguard is pasteurization.

The same general principles must apply to the production of potable water. The watershed must be protected, insuring that the water will be kept as clean as possible along each step of the route. In addition, the water finally must undergo a degree of treatment consistent with the hazards to which it has been exposed.

Further comparison might be made with fire protection in communities. In the first place, we provide ourselves with regulations concerning construction of our manmade works so that fire hazards are reduced as much as is economically practical. Second, sufficient quantities of water and adequately manned fire-fighting facilities are provided to extinguish any fires which may occur. Finally, there is continuing surveillance and inspection. These examples illustrate the philosophy of providing factors of safety. It is not permissible so to lower factors of safety as to compromise the health and safety of the public.

Esthetic Considerations

The California State Department of Public Health recently had an inquiry from a person who asked why some of our water supply reservoirs were not open for swimming and bathing. In part, the department replied that the public is unwilling to accept such use of its domestic water supply reservoirs. The interest of the swimming recreationalists, on one hand, and the interest of the water consumer, on the other hand, are incompatible. Under such circumstances the conservative point of view should prevail. Therefore, it is more important to satisfy the esthetic senses of the thousands of water users than to develop unrestricted use of water supply reservoirs which seriously degrades the esthetic quality of the water.

The California State Board of Public Health, in whose hands the legislature has placed the responsibility for granting permits to water purveyors, is limited in its action by the State law which, in section 4016 of the Health and Safety Code, states: "If . . . the board determines, as a fact, that the water furnished or supplied or proposed to be supplied is such that under all the circumstances and conditions it is impure, unwholesome or unpotable or may constitute a menace or a danger to the health or lives of human beings, or the existing or proposed plants, works, system or water supply are unhealthful or insanitary, or not suited to the production or delivery of healthful, pure and wholesome water at all times, it shall deny the permit and order the petitioner to make changes as necessary to secure a continuous sup-

ply of pure, wholesome, potable, and healthful water."

My point in quoting this is to refer to the adjectives "wholesome" and "potable." The State board of public health holds that wholesomeness and potability also include esthetic considerations. When the water-consuming public considers that certain uses of sources of water are repugnant, then it is quite obvious that the water derived from these sources cannot be considered to be wholesome and potable. We must therefore recognize the feelings of the consumers, and we cannot permit uses of their water sources which are esthetically unacceptable. For this reason, the regulations which the State board of health adopted in December 1956 forbid recreational use involving "bodily contact" by man or animals.

Public Health Considerations

Wherever recreational use of water supplies is undertaken, there must be adequate control, for only with adequate control can such uses be tolerated. There must be assurance that the limits of contamination are not exceeded. Sanitary facilities adequate for the numbers of people in the area must be provided. The facilities must be convenient and they must be esthetically acceptable to the users. This includes their proper maintenance. Last but not least, there must be policing of the people in the area in order to keep their activities within limits consistent with the character of the area in which they are carrying on their recreational activities. The water purveyor must give assurance of this supervision. In addition, the local public health department having jurisdiction over the reservoir must provide appropriate public health supervision.

The State board of public health has considered matters of recreation on water supply reservoirs in the past. In 1951 it granted a permit to the city of San Diego to allow fishing on its reservoirs and in consideration of this action adopted a policy statement concerning recreation on reservoirs. At its meeting on December 7, 1956, the State board of public health formalized this earlier policy statement and adopted regulations on this subject. Problems described above have been taken into account in the regulations, which call for (*a*) limiting the activities of people on the water supply reservoirs; (*b*) providing adequate sanitary facilities for use of the people; (*c*) maintaining these facilities; (*d*) policing the people in the area; and (*e*) providing an adequate degree of treatment of the water derived from these sources.

Conclusions

1. Water reservoirs may afford a healthful recreational resource for a community.
2. Because water is a vehicle of disease transmission, when a choice must be made between safe water or recreation, safe water must always prevail.
3. Recreational use of water supply reservoirs calls for a high level of supervision and control of people using the area to prevent their wastes from entering the waters.
4. Control of the recreational activities must be adequately budgeted and financed.
5. There must be adequate treatment of water derived from reservoirs.
6. Determination on the basic question of recreational use of water supply reservoirs must be made locally.

We must recognize that permitting such recreational activities constitutes a risk, but that the risk can be minimized to a reasonable and tolerable level if the conditions described are met.

REFERENCES

(*1*) Rudolfs, W., Falk, L. L., and Ragotzkie, R. A.: Literature review on the occurrence and survival of enteric, pathogenic, and relative organisms in soil, water, sewage, and sludges, and on vegetation. I. Bacterial and virus diseases. Sewage & Indust. Wastes 22: 1261–1281, October 1950.

(*2*) Taylor, E. W.: The examination of waters and water supplies. Ed. 6. Philadelphia, Blakiston, 1949, p. 501.

(*3*) Neefe, J. R., Baty, J. B., Reinhold, J. G., and Stokes, J.: Inactivation of the virus of infectious hepatitis in drinking water. Am J. Pub. Health 37: 365–372, April 1947.

(*4*) Gilcreas, F. W., and Kelly, S. M.: Relation of coliform organism test to enteric-virus pollution. J. Am. Water Works A. 47: 683–694, July 1955.