

port further economic expansion.

Since at least 1970, a constant 29% of the growing U.S. population continues without the benefit of sewer systems, relying instead on riskier septic tanks (*Statistical Abstract of the United States* 1985, p. 200).

Sewage collection. The problem of breaks in sewer pipes is getting worse in the older cities: New York, the Eastern Seaboard, and the Great Lakes cities, according to Martin Tiemens, Deputy Director of the Municipal Services Division of EPA. Most cities do not have good data on the condition of their sewers. Some do not even have maps of all their pipes.

In older cities, domestic sewage and storm water are carried away in the same pipes, leading to overflows of raw sewage into rivers and bays when heavy rains exceed the capacity of the system. The pipes also frequently release raw sewage when the gates and valves in these old systems become stuck open, and are not detected. There has been dramatic progress in eliminating combined sewers since the Clean Water Act became law in 1972. Yet the EPA Needs Survey for 1984 shows a population of 44 million is still served by combined sewer systems. More than half of the work to be done is concentrated in six states: New York, Illinois, Massachusetts, Pennsylvania, Ohio, and Indiana (\$14 of \$23 billion).

Adequate sewage collection and treatment is vital for public health. Among the waterborne diseases are cholera, hepatitis, salmonella, and typhoid. Providing sewers in unsewered areas eliminates the most serious threat to public and private underground sources of water. The requirement of secondary treatment for wastewater—i.e., elimination of 85% of conventional pollutants—typically eliminates more than 90% of bacteria.

Crisis management and selective investment

As of now, the infrastructure crisis is being approached only on the basis of crisis management and selective investment. The legislation passed in the last seven months is still within that context, useful though it is. In the name of that approach, the National Council on Public Works Improvement was established in late 1985 under a mandate from Congress, and issued a report, *The Nation's Public Works—Defining the Issues* last September. The Council essentially consists of tax-exempt bond salesmen and government representatives. Executive director Nancy Rutledge explains that the Council has no mandate to gather new information on the condition of infrastructure, and “sees no further value in a call to arms.” The Council is instead “seeking a better methodology for appraising needs.”

But the bacteria and the parasites and the viruses have no respect for selective investments. Nothing less than the creation of cheap new credit for production—in the manner and scale of our gear-up for World War II—will rebuild America's infrastructure.

Testimony: Dr. Abel Wolman

The importance of a worst-case scenario

The following is an excerpt from the Oct. 17, 1986 testimony of Dr. Abel Wolman, In the Matter of the Application of the Village of Delhi, before the New York State Department of Environmental Conservation. Dr. Wolman is an internationally distinguished pioneer in sanitary engineering and professor emeritus at Johns Hopkins University, Baltimore, Maryland. The treated sewage of the Village of Delhi, population 5,000, is discharged into waters that form part of New York City's water supply. However, the village is seeking authority to stop disinfecting this wastewater, to stop monitoring the level of fecal coliform bacteria contained in it, and to relax the level of permissible remaining suspended particles. The village has made various arguments on behalf of this desire, but clearly, the motivations are purely financial. Dr. Wolman was asked about the potential public health consequences.

New York City policy requires that all sewage treatment plants disinfect effluent which enters New York City's water supply. The logic of this requirement is inescapable. Sewage represents one of society's most potent sources of human pathogens, and its disinfection represents a proven prophylactic measure which has saved millions of lives. . . .

New York City's demand for continued disinfection of all sewage plant discharges in its watershed is reasonable. Alternatives to chlorination could be supported where such alternatives are at least as effective, reliable, and enforceable as established chlorination practices. The DEC's [Department of Environmental Conservation] proposal contains no consideration of alternative disinfection methods. Significantly, it also fails to take into consideration the consequences of a worst-case scenario.

Q: What is the rationale for using a worst-case scenario in assessing proposals of this type?

Dr. Wolman: One should never lose sight of the occurrence of unexpected natural and man-made accidents which materially disturb the management success! Dependence upon the “average” conditions is always fraught with danger, since average behavior of a river conceals the high importance of floods and droughts. The consequences of nature's misbe-

haviors requires even more stringent control. The old aphorism should be remembered of the individual who drowned in the river of average depth of four feet. Unfortunately, he fell into it where it was eight feet deep.

In addition to the unpredictability of natural events, the failings of man-made devices must also be taken into account. Breaks in sewers, failures of pumps, unexpected excessive loads upon waste-water treatment plants are usual. All these events change downstream behavior, usually for the worse. Faith in average conditions operating to perfection when under nature's stress should not delude us; the unexpected *does* happen. Epidemics are, by definition, the result of a set of concomitant improbabilities that, when taken together, represent a worst-case scenario.

Q: Can you give an example of why it is important that worst-case scenarios be evaluated when proposals of this type are considered?

Dr. Wolman: Yes. A waterborne typhoid fever epidemic occurred in Keene, New Hampshire, in the latter part of 1959. Its water supply came from watersheds largely wooded, largely uninhabited, and the shoreline of storage reservoirs entirely controlled by the municipality. No recreational use was permitted and sanitary restrictions were presumably enforced. The water was filtered by slow sand filters and by not-too-well-controlled chlorination.

October 1959 was a month of heavy rainfall. On Oct. 24 and 25, a total of 4.29 inches of rain fell. The total for the whole month was 7.84. Pollutational materials in the upper reaches of the drainage basin were quickly transported down into the system. Unfortunately, at the same time, the filters were being cleaned and were just being put back into service, with the usual delay in reaching maximum efficiency.

On Nov. 6, the first patient, a six-year-old boy, was admitted to the hospital. Between Nov. 10 and 14, four more arrived. During the next several days, the remaining 9 of 14 recognized cases of typhoid developed. One subsequently died of other complications. The investigations as to origin were performed jointly by state and local authorities and the Epidemic Intelligence Service of the U.S. Public Health Service.

Why did the epidemic occur? We should be reminded of the inelegant fact that typhoid occurs only when the individual has swallowed, via water or food, the discharges of another person. Where was that person on a so-called "uninhabited" watershed? In spite of supposed periodic inspections, a lumber camp had been operating with three men for many months, with no toilet facilities. Their wastes were carried rapidly downstream and eventually into the mouths of the patients.

The improbable coincidence: all the patients were infected with *Salmonella Typhi* Phage Type E. The same organism was recovered from the discharges of one lumberjack carrier of the disease.

What had this unfortunate episode taught us? . . . The threat of intestinal waterborne disease is still very much a reality, despite the general excellence of water supply quality which has been established over the years through the progressive efforts of water supply management, engineers, and health authorities. Here, a "worst-case" of circumstances was required to produce illness of epidemic proportions, namely, the human carrier, torrential rains and a filter plant delayed in efficient performance. The rarity of occurrence is verified by the fact that this lumber camp existed unknown on the watershed for well over a year without prior incident. . . .

Q: Is the problem you just described strictly an event of the past?

Dr. Wolman: No. Some may well argue that the Keene event is interesting historically, but typhoid is practically unknown now in the U.S. The danger of this assumption is apparent from the following: Between August 25 and September 1, 1986, ten cases of typhoid have been hospitalized, with one in intensive care. All have been traced to one restaurant in a well-known national eatery chain in Silver Spring, Maryland.

The carrier of the disease has been found. She is a cook at the restaurant and has been an immigrant in this country about four years. She comes from a country where typhoid is still prevalent. One of the health department's epidemiologists described typhoid fever as one of the "forgotten diseases" in the U.S. It is rare, but its reappearance cannot be forgotten—and certainly its absence should not be a basis for eliminating basic protections for drinking water supplies.

The late George C. Whipple, at Harvard, pointed out that the "world is bound in bacterial bonds." With the tremendous increase everywhere in the mobility of people, the axiom is truer today than ever before. The seventh cholera epidemic in history began in 1961. It now affects 93 countries globally. Tens of thousands of cases are occurring. Fatalities are as high as 30%. The disease is spreading, reaching Hong Kong where it had not previously been widespread. Ambulant carriers are not in short supply and they do travel rapidly and bear their malignant baggage everywhere. On the New York City watersheds, people come and go. We cannot assume that no infected individuals will land at Delhi or elsewhere in our region. Eternal vigilance is the key, since cholera, as other diseases, is acquired, not by spontaneous generation, but by ingestion of water or food contaminated by the organisms coming from the fecal discharges of an infected person. Water remains the most important vehicle of transmission.

Q: Do you have any further observations regarding the proposed modifications to the Village of Delhi SPDES permit?

Dr. Wolman: Yes. It is ironic that the proposed changes are being considered at the very moment when EPA is acting to impose more stringent criteria for drinking water under the federal Safe Drinking Water Act. . . .