HEALTH RISKS FROM CONTAMINATED WATER: DO CLASS AND RACE MATTER?

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The impact of contaminants in water on minorities and economically disadvantaged persons was reviewed. Environmental legislation governing water was summarized as background information against which relevant studies were evaluated. The majority of the available information was anecdotal or case study

1. This manuscript has not been subjected to review by the authors' agencies and institutions. The views expressed are solely those of the authors and do not necessarily represent the policies of their respective organizations.

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3. Key Words: drinking water, environmental equity, water.

4. Abbreviations: ATSDR, Agency for Toxic Substances and Disease Registry; AWWA, American Water Works Association; BA, barely acceptable; CDC, Centers for Disease Control and Prevention; CWA, Clean Water Act; EPA, U.S. Environmental Protection Agency; GI, gastrointestinal; HERL, Health Effects Research Laboratory; MCL, maximum contaminant level; NCHS, National Center for Health Statistics; NPL, National Priority List; PCBs, polychlorinated biphenyls; PHS, Public Health Service; RU, relatively unpolluted; SDWA, Safe Drinking Water Act; VWP, Virginia Water Project; FDA, Food and Drug Administration.

Toxicology and Industrial Health, Vol. 9, No. 5, pp. 879-900

ISSN: 0748-2337

and did not lend itself to making quantitative comparisons or analyses. However, the data did present certain trends that led to the conclusion that inequities concerning exposure to contaminants in water may exist. The following recommendations were made: current data bases should be analyzed and new data bases created to facilitate assessments of exposure to waterborne contaminants to all populations; an analysis of populations not covered by the Safe Drinking Water Act should be undertaken; a survey should be conducted of the drinking water infrastructure and the results evaluated to identify any impacts to minorities and economically disadvantaged persons; the social, cultural and economic characteristics that influence human exposure to waterborne contaminants need to be identified; and better educational and community outreach programs need to be developed and implemented.

INTRODUCTION

A report on Environmental Equity, recently released by the Environmental Protection Agency (EPA), concluded that data on the health effects of environmental pollutants by race, ethnicity, and income are generally lacking (U.S. EPA, 1992). However, some differences by minority status in exposures to environmental pollutants are documented. A major recommendation of the EPA report was that a research program be established to provide data on health risk by minority status. As a first step in establishing such a program, this paper examines the evidence concerning water contamination and its effects on minority populations.

As a result of the billions of gallons of waste water that is discharged to our streams and onto our lands, together with the millions of tons of solid and gaseous wastes that are discharged to the environment, the safety and quality of our water supplies are threatened in a manner not previously considered significant. Our water resources, more perhaps than any other, illustrate the interaction of all parts of the environment and particularly the recycling process that characterizes every resource of the ecosystem. Everything that we inject into the biosphere—chemical, biological, or physical—can ultimately find its way into the earth's water. These contaminants must be removed by nature or by technology before that water is again potable. It is easily recognized that, while it may vary in degree, there is a direct relationship between the water we waste and the water we drink. Water pollution can never be considered separately from water supply. Therefore, the scope of this paper covers water in all its uses and potential contacts with humans. This includes the water from which we drink and in which we bathe, recreate, and fish or otherwise harvest edible aquatic life.

In this paper, the term "minority" refers to any group defined by race (African Americans, Asians, Native Americans) or by ethnicity (Hispanics or Latinos). The term "socioeconomic status" refers to the classification of populations by income level, education, occupational status, or some combination of these factors. The importance of socioeconomic status and

some problems with its interpretation are discussed in another paper of this proceedings (Wagener et al., 1993). The term "economically disadvantaged" refers to any group that is found in the lower ("poorer") end of the economic scale.

Legislative History

For nearly 80 years the United States has had legislation and regulations designed to protect the public from diseases associated with drinking contaminated water. The first official standard for drinking water—a bacteriological standard proposed by the Public Health Service (PHS)—was established in 1914. This standard was adopted because regulators needed a standard against which to measure the sanitary condition of water systems throughout the nation to ensure that drinking water would be equally pure in all 48 states. From 1914 to 1975, this standard was used by federal, state, and local health authorities and by water works officials to improve the nations' community water systems and to protect the public against waterborne disease. During this time, the standards were broadened to include maximum permissible concentrations of certain heavy metals, total solids, alkalinity, and radioactivity.

Further efforts to extend or broaden the PHS Drinking Water Standards were stopped when it was determined that the PHS legislative base for the standards was restricted to controlling communicable disease. Growing concerns for the safety of drinking water led to the passage of new legislation, the Safe Drinking Water Act (SDWA) of 1974. The Act required the Administrator of the Environmental Protection Agency (EPA) to promulgate *national drinking water standards* and, for the *first time,* to promulgate regulations for enforcing them.

The SDWA *directed* the EPA to *identify substances in drinking water* "which in the judgement of the administrator may have any adverse effect" on the public health. In compliance with the requirements of the Act, National Interim Primary Drinking Water Regulations were promulgated in December 1975. Following promulgation, the regulations have been amended many times, illustrating their viability as a living document. Developing standards involves an intensive technological evaluation that includes assessing the occurrence of the substance in the environment, human exposure in specific and in general populations, adverse health effects, risks to populations, methods of detection, chemical transformation of the contaminants in drinking water, and treatment technologies and costs.

The control of discharges or waste into water is governed by the Clean Water Act (CWA) of 1972. The CWA's primary goal is to restore, maintain, and preserve the integrity of the nation's waters. Its interim goal is to "assure. . . the protection and propagation of a balanced population of shellfish, fish, and wildlife, and allow recreational activities in and on the water. . . ." These goals have been termed fishable and swimmable waters. They are accomplished under two basic regulatory principles: technology-based standards that mandate a level of effluent quality achievable using pollution control technology, and standards based on water quality. Water quality-based standards describe the quality required for a particular body of water; these standards, which are the permissible amounts of pollutants allowed, are based on

the designated use (e.g., swimming, industrial, drinking water) of the water into which the pollutants are being discharged.

This brief introduction to the history of the government's efforts to provide uncontaminated drinking water and to prevent further contamination of water is *intended to establish a basis* against which to measure the findings of this report. One must recognize that the government regulates only established community and noncommunity water systems larger than a certain size; 40 million people use unregulated water systems. The federal government *does not require* the establishment of a water system, nor does it *control* the quality of the water supplied by systems not under its jurisdiction. Nevertheless, in conducting research to support its responsibilities to set standards, the federal government provides information on adverse effects applicable to contaminants in all drinking water systems.

The quality of drinking water supplied by most of the community water systems in the United States is unsurpassed by that of any other country in the world. Even so, many citizens, both inside and outside the protection of the SDWA, do not have the same confidence in the safety of their water supplies that most of us take for granted. Perhaps we should be asking ourselves certain questions. What is the government's responsibility to all of its citizens when it assesses environmental impacts on our water supplies? What are the human exposures in specific populations as well as in the general population? Do associated risks vary with different population groups? Should the SDWA provide for those different population groups? Should the SDWA and the CWA provide protection for water supply sources used by all persons when those sources of supply are impacted by industrial, solid, hazardous, and toxic wastes or by uncontrolled agricultural runoff? Should all employers be required to provide a safe available source/supply of drinking water to their employees at the work site, and in the home if the employer provides living accommodations? Does, or can, other environmental legislation provide the protection encompassed in these questions? Is the intended protection of that environmental legislation uniformly implemented and enforced across population groups that are distinguished by class, race, and ethnicity? Does the enforcement of these laws impact unfairly on certain populations by removing significant sources of foodstuffs?

To examine these questions the existing data and literature were reviewed. Many reports of the "gray"[1] literature have been included in the works cited. Their accuracy or validity has not been ascertained, and they are reported here as case studies. This paper does not represent an exhaustive literature review, but it attempts to cover most of the significant information available at this time.

THE BASIS FOR ENVIRONMENTAL EQUITY

There are dramatic differences in death rates, infant mortality, life expectancy, and disease rates based on ethnicity, race, and socioeconomic status in the United States. For all causes of

[1] Publications not subjected to scientific peer review.

death, death rates for blacks (58%) and for Native Americans (13%), were higher than for whites (NCHS, 1991). In 1980, the life expectancy of whites (70 years for males, 78 years for females) was higher than for blacks (64 years for males, 73 years for females) and for Native Americans (67 years for males, 75 years for females) (Indian Health Service, 1991; NCHS, 1991). The infant mortality rate between 1984 and 1986 was substantially lower for whites (8.8 per 1000 live births) than for black (18.3 per 1000 live births) and for Native Americans (13.5 per 1000 live births) (NCHS, 1991).

Socioeconomic information indicates that, on average, racial and ethnic minorities are poorer, less educated, have higher rates of unemployment, and are less likely to be covered by health insurance. In 1990 (Bureau of the Census, 1991), the median household income for whites ($31,435) was higher than for blacks ($19,758), and for Hispanics ($24,156). A higher percentage of whites completed high school (77.9%) as compared with blacks (63.1%) and Hispanics (59.8%) (Bureau of Census, 1992). Fewer whites (4.7%) were unemployed compared to blacks (11.7%) and Hispanics (8.2%). Finally, blacks and Hispanics were less likely to be covered by health insurance (79.6% and 69.9%, respectively) than whites (87.4%).

Recent reports on the interaction of race/ethnicity with socioeconomic status have shown continued racial/ethnic differences when accounting for socioeconomic status. These include reports on higher blood lead levels in black children (ATSDR, 1988), and racial differences in cancer rates (Baquet et al., 1991) and chronic respiratory conditions (NCHS, 1991). These racial differences are explored in more detail in another conference report (Montgomery and Carter-Pokras, 1993). In defining health disparities among minorities, it is unclear what role the environment plays given economic, social, cultural, and biological considerations.

In 1990, a conference on "Minority Health: A Focus on the Environment" was held in Atlanta, Georgia. At this conference several case studies and reports relating minority health and environmental contamination were presented. Fernandez et al. (1990) found that lead poisoning in Chicago children is higher in blacks and Hispanics. Residents of the Navajo Reservation are directly exposed to ionizing radiation emitted from abandoned mine sites (Antonio et al., 1990). Air, food, ground and surface water are contaminated with heavy metals and ionizing radiation.

Ransom and co-workers (1990) reported a minority community's successful efforts to force the clean-up of a nearby landfill that was leaking PCBs into the ground water. In another predominantly minority community, protesters were jailed when they demonstrated against placing soil containing PCBs in a landfill in their community (Bullard, 1990). They were unsuccessful in preventing placement of the contaminated soil. Since landfills undoubtedly pose an ever-present danger to our ground water supply, few communities openly accept this means of disposal if it can be avoided. A national study found race to be the single most important factor in locating toxic waste sites (now abandoned) across the nation (Commission for Racial Justice, 1987). The report concluded that urban minority populations are at greater risk from the nation's abandoned waste sites and the potential contamination of their water

supply than their nonminority counterparts. The following section reviews several studies and reports of differential exposures to microbial and chemical contaminants in drinking and ambient water.

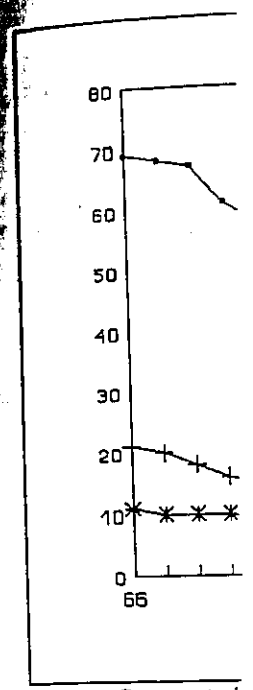
CASE STUDIES: DRINKING WATER

In evaluating these reports it is useful to give some context to the complexity of understanding environmental exposure and health effects relationships. Drinking water issues can be categorized into two basic areas: quality (microbial, chemical, and physical) and quantity (availability). A concept for explaining and studying these relationships was recently proposed by Sexton et al., (1992) as an environmental health paradigm linking sources, environment, exposures, dose, and effects. This paradigm demonstrates the complexity of the relationships between environmental contaminants and health effects in humans. When applied to water, this paradigm emphasizes that the factors defining exposure to water pollutants are not completely known and their relationship to health effects is often uncertain. There are exceptions such as the relationship between water contaminated with enteric microbial pathogens and disease (cholera, typhoid fever, dysentery etc.)

Water quantity issues affect not only the quality but other aspects of daily life. Standards of hygiene and cleanliness are directly related to a variety of health effects. The availability of water is a major determinant of how well these standards can be maintained. In evaluating the information below, it is important to understand that in many cases, the relationship between exposure and effect is not known for the minority group but also is not know for the general population as well.

Microbial Exposures

Infectious disease rates among minority populations. Investigators have examined the mortality rate from infectious diseases among American Indians, Hispanic whites, and other whites in New Mexico (Becker et al., 1990). Overall, they found a steady decline in the death rate from infectious disease since 1958. However, American Indians still had the highest mortality rates, followed by the mortality rates of Hispanic whites compared to other whites. While the study did not control for socioeconomic status or for access to medical care, the authors noted that many of the American Indians in New Mexico live in crowded homes with no running water. According to Indian Health Services Tribal Activities Bulletin (1991), in 1955 more than 75% of Native Americans were living in homes without essential sanitation facilities, and the age-adjusted death rate for gastrointestinal disease among them was 15.4 per 100,000 population, which was 4.3 times higher than for other races in the United States. Over the past 20 years, the death rate from gastrointestinal disease for Native Americans has dropped to 2.1 per 100,000 population, and the percentage of their homes having sanitation facilities has increased (Figure 1). However, while the gastrointestinal death rate has been dramatically reduced, it is still higher than that reported for whites (less than 1 per 100,000 population). What is not known is how much of this difference in disease rates is related to water quality, quantity, or both.



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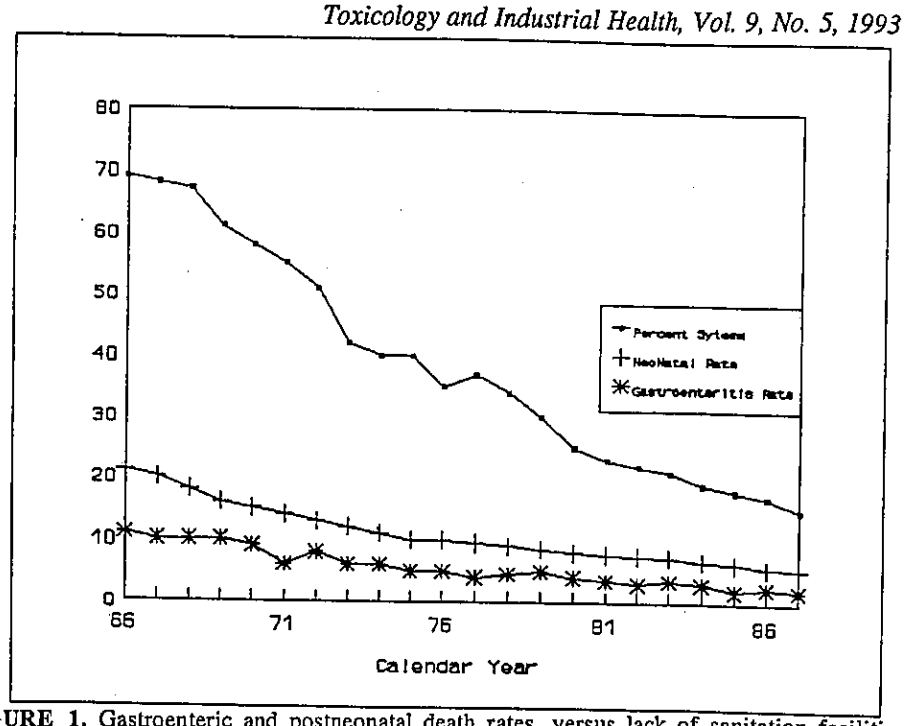


FIGURE 1. Gastroenteric and postneonatal death rates, versus lack of sanitation facilities, for American Indians and Alaska Natives. Source: Tribal Activities Bulletin, 1992.

Microbial quality: Indian reservations. An EPA study on Indian Drinking Water Supply (1988) found that 6% of all water systems on Indian reservations reported at least one maximum contaminant level (MCL) microbial violation. In addition, not all systems were monitored consistently, and 36% reported monitoring violations. In most cases, the reported violations were attributed to distribution systems rather than to the quality of the source water. Although the poor microbial quality of the Indian reservations water might be linked to the higher infectious disease rate, no studies supporting this relationship were found.

Poor drinking water quality in migrant camps. Migrant farmworkers often experience primitive living conditions that can impact their health. There is evidence that among the environmental health problems faced by these laborers is lack of access to water of good quality. Arbab and Weidner (1986) compared the racial/ethnic make-up and water quality of migrant camps with that of other farm housing. They found that migrant camps are often overcrowded and that the majority of the occupants are Hispanic (75%) or Native American (20%).

Arbab and Weidner (1986) compared illnesses among migrant workers and other farmworkers in Utah, and found that when compared to other farmworkers, migrant workers had twice the incidence of diarrhea. The lack of facilities or the poor quality of the facilities may be related to this high illness rate.

Ciesielski et al. (1991) in North Carolina found that a significant number of drinking water supplies for migrant camps tested positive for total coliforms (44%), fecal coliforms (26%)

and *E. coli* (20%) while none of the water supplies on other farms in the same area were positive for these organisms.

Other evidence suggesting exposure to poor quality drinking water supplies includes an outbreak of typhoid fever that occurred when the residents of a migrant camp in Dade County, Florida, ingested contaminated well water in February and March, 1973 (Hoffman et al., 1975).

Chemical Exposures

Ground water contamination from hazardous wastes in rural poor counties. In 1990, an environmental remediation firm called "Clean Sites" investigated the presence of hazardous waste sites in counties inhabited by the rural poor and the potential for their populations to be exposed to toxic substances in drinking water. They defined a rural county as having a population of less than 50,000 people; a poor county was defined as one with annual per capita income of less than $9,320. In the more than 3,000 counties in the United States, Clean Sites found 470 counties that met these definitions in 1980. Based on 1980 census data, most people in rural poor counties are white and between the ages of 6 and 64. However, there are higher percentages of blacks, Native Americans, children, and elderly people in rural poor counties than in all other counties in the country (Table 1). The U.S. Geological Survey found that 97% of the rural U.S. population relies upon ground water for drinking.

TABLE 1. Race in Rural Poor Counties

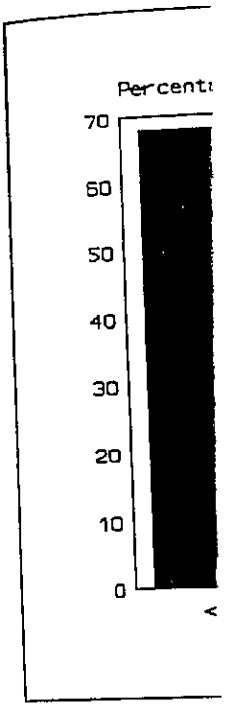
Race/Ethnicity	Population in Rural Poor Counties (%)	Population in United States (%)
White	73.5	83.4
Black	20.6	11.7
Native American*	3.5	0.7
Asian/Pacific Islander	0.9	1.6
Other	1.5	2.6
Total	100.0	100.0
Spanish origin**	5.0	6.5

*Includes Indians, Eskimos, and Aleutians.

**Because persons of Spanish origin can be of any race, persons counted in this category may overlap with those counted in some of the other categories.

Source: U.S. Bureau of Census (1980), as provided by the U.S Department of Agriculture, Economic Research Service (from Clean Sites).

The Clean Sites study found that 1,202 hazardous waste sites, and 23 National Priority List (NPL) sites are located in rural poor counties. Given the fact that waste sites are nominated to the NPL on the basis of their potential for adverse human exposure, one would expect to find that many NPL sites have contaminated ground water nearby. The Clean Sites study reported that contaminated ground water occurs at 16 (70%) of the 23 NPL sites in rural poor counties. Ground water is used as a source of drinking water near all 23 NPL sites. The study reported similar findings for hazardous waste sites not on the NPL.



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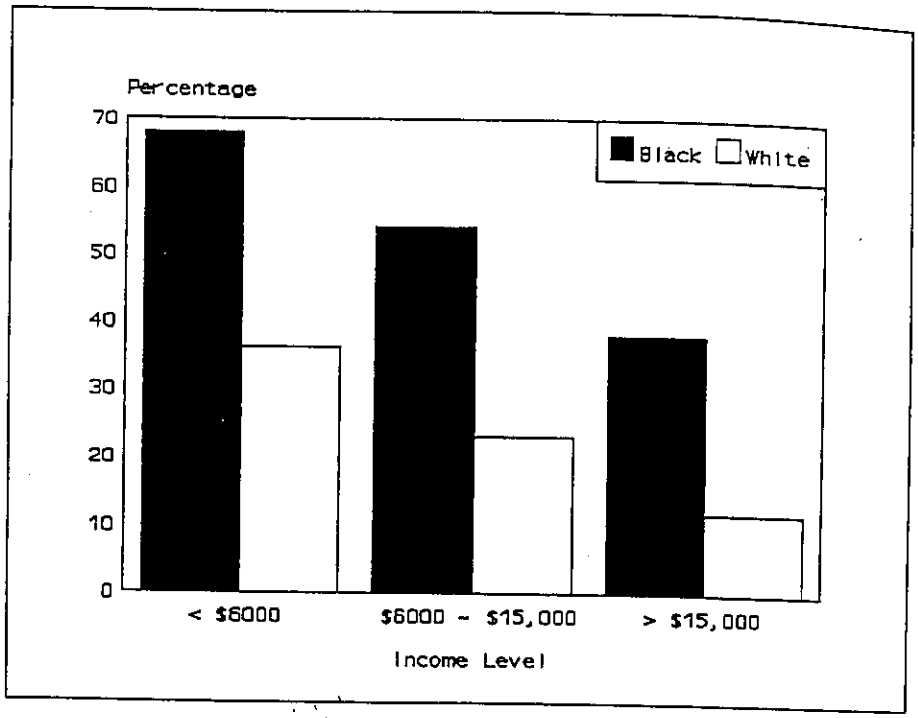

FIGURE 2. Percentage of urban children aged 6 months to 5 years with elevated blood lead levels (> 15 µg/dl), by race and income. Source: ATSDR, 1988.

Drinking water and sanitation along the US/Mexico border. The identification of a cluster of anencephalic births along the US/Mexico Border in Brownsville, Texas (Adler and Annin, 1992) initially focused on environmental pollutants as a possible cause. One reason for concern was that raw sewage and industrial wastes enter the Rio Grande River above Brownsville. The Texas Department of Health and the Centers for Disease Control and Prevention (CDC) conducted a case-control study and determined that neither drinking water nor proximity to the Rio Grande River were related to the risk of anencephaly. Furthermore, existing water quality data showed that the concentrations of pollutants in drinking water were mostly at or below state standards (Texas Department of Health, 1992). This episode is important in demonstrating the value of environmental monitoring programs to evaluations of public health problems.

The lack of clean drinking water and human waste sanitation for the mostly Hispanic population living along the US/Mexico border is among the greatest public health problems in this region. In Texas, 280,000 people live in developments called "Colonias" which are characterized by the absence of adequate sewage treatment (256,000 persons) and lack of safe drinking water (87,000 persons) (Texas Water Development Board, 1992). The lack of clean drinking water and adequate sanitation is in turn partially responsible for the three-fold increase

in rates of waterborne diseases and hepatitis A in Texas border counties (Texas Governor's Border Working Group, 1992).

Lead and drinking water. The relationship between blood lead levels and race/ethnicity and socioeconomic status has been well-documented (ATSDR, 1988; Schwartz and Levin, 1992). When accounting for socioeconomic status, blacks still have higher blood lead levels than whites (Figure 2). For residents of homes with plumbing that have lead service lines or lead solder, drinking water could be the primary source of lead. Plumbing could be a major source of lead exposure in the older housing typical of urban areas. The relative role of drinking water as a source of lead, however, is believed to be small when there is also exposure to lead in paint. EPA has estimated that drinking water typically contributes about 20% to the total lead exposure for an average two year-old child (U.S. EPA, 1988).

Availability Of Drinking Water

The 1980 census reported that, while the number of houses without indoor plumbing had been declining, there were large differences by race in populations that reported living in houses without plumbing. More Native Americans than any other group (7.3%) lived in houses without plumbing, while 2.2% of blacks, 0.85% of people of Spanish origin, and 0.43% of whites lived in such houses. In many rural and poor communities, households are dispersed over such a wide geographical area that a centralized water system is financially and technically infeasible (Virginia Water Project, 1988). Many low-income people either have no access to, or cannot afford to hook up to, a municipal water system (Goldman, 1991). The problem is conspicuous in the West where Native Americans often have limited options because there are insufficient water supplies. The EPA reported that most tribes experience seasonal water shortages, and few have alternative water supplies (U. S. EPA, 1988). In 1986, 14.5% of all Indian water systems were unable to deliver drinking water or bacteriologically safe water for 18 or more days.

Rural water supplies. EPA surveyed 2,600 rural households when it conducted the *National Statistical Assessment of Rural Water Conditions* (U.S. EPA, 1984). Only 8.7% of rural households were nonwhite, and the median income for all households was $12,818, lower than the median for all U.S. households. Water samples were collected and analyzed for several microbials and chemicals. Total coliforms were the most prevalent problem, exceeding the reference in 28.9% of all rural households. Households with low income (under $10,000) and low education (less than high school) were more commonly found to have more coliform problems than other households. Elevated levels of mercury in drinking water were found in 24.1% of all rural households. An estimated 3.2% of households reported that the quantity of their water supply was usually or always insufficient. At the extreme, 1.7% of rural households reported hauling water from other supplies on a regular basis (U.S. EPA, 1984).

Water quality in Virginia's urban and rural communities. The Virginia Water Project, Inc. (VWP) prepared a report in 1988 on drinking water and waste water needs in rural Virginia communities. The study did not examine water system issues for minorities, but the

information that the project assembled supports the belief that poor communities are more likely to have inadequate drinking and waste water systems. VWP found that counties with the lowest family income have the highest percentages of:

- inadequately drilled wells,
- inadequate disposal systems,
- individual dug wells that have been installed without approved construction, and
- water systems that cannot be corrected with present technology.

These data suggest that residents of poor and rural communities are more likely to be using water supplies that could become contaminated (Table 2). Examples of two counties are given in Table 2.

TABLE 2. Comparison of Key Indicators of Quality of Water Supplies and Sanitation Systems in Two Counties in Virginia, by Income Levels

Key Indicators	Nelson County	Powhatan County
Median Family Income (1979)	$14,404	$20,710
Population (1980 Census)	12,204	13,062
Families below the poverty level	14.6%	7.7%
Number of homes with failing or inadequate disposal systems	16.6%	10.1%
Number of systems not correctable with present technology	88.0%	4.0%
Number of inadequately constructed individually drilled wells	90.0%	10.0%
Number of individually dug wells not using approved construction	95.0%	25.0%

Source: Virginia Water Project, 1988

Infrastructure Of Water Systems

There are an estimated 436,000 miles of water distribution pipe in the United States (AWWA, 1992). In many of the largest cities in the U.S., the distribution system could be 80 to 100 years old. The pipes in these systems leak and are susceptible to cross-connections and sewage contamination. Less than 1% of the total pipe in the distribution system is replaced on an annual basis. A 5-year review of outbreaks of waterborne disease in this country that were related to drinking water showed that, while most outbreaks (51%) were due to treatment deficiencies, 12% were due to distribution deficiencies (CDC, 1990, 1991). Exposure to lead in drinking water may be due to the existence of lead mains installed 50 years ago. The exact status of the infrastructure of the distribution system or of the treatment plants themselves is unknown. It is assumed that, like other infrastructure (roads, bridges, train track, etc.), it is in decline. The extent of the impact of this decline upon poorer communities or specific minority populations is unknown.

CASE STUDIES: AMBIENT WATER QUALITY

Microbial Exposures

Bathing beach studies. Sewage is a common source of infectious disease agents in ambient

water. Minority populations could be affected by microbial contamination through activities such as swimming on urban beaches contaminated by domestic sewage. Minority populations and the poor may not only have limited access to recreational waters but those that are available may not be safe.

EPA's Health Effects Research Laboratory (HERL) conducted a series of studies between 1972 and 1979 to develop water quality criteria, based on health effects, for marine recreational waters (Cabelli and Dufour, 1983). The studies provided information on the demographic characteristics of beach users and on gastrointestinal disease rates among the users who responded to surveys conducted in New York and New Orleans. The survey in New York included two beaches: one considered to be a barely acceptable (BA) beach because a nearby beach had to be closed due to pollution; and another considered to be a relatively unpolluted (RU) beach. The predominant ethnic/race group on the two beaches was Hispanic; whites were the next most prominent, then blacks (see Table 3).

TABLE 3. Demographic Characteristics of Beach Users in a New York City Study

Group	Demographic	Percentage			
		BA Beach*		RU Beach*	
		Swim (N = 1961)	Nonswim (N = 1185)	Swim (N = 2767)	Nonswim (N = 4156)
Sex					
	Male	44.0	33.5	46.9	27.1
	Female	56.0	66.5	53.1	62.9
Age Group					
	0-9	24.8	10.1	26.7	26.4
	10-19	36.1	12.7	21.3	11.7
	20-39	14.4	65.2	43.1	47.7
	>39	24.5	12.0	8.9	14.4
Ethnic Group					
	Hispanic-American	47.6	33.5	52.6	53.1
	White	36.8	37.4	30.1	29.6
	Black	15.4	29.1	17.3	17.3
Person/rooms ratio**					
	< 1.0	26.2	21.8	21.3	29.5
	1.0-1.3	32.7	40.8	40.6	39.2
	> 1.3	41.1	37.4	38.1	31.3

*BA = barely acceptable; RU = relatively unpolluted

**Number of persons in household divided by number of rooms in household, as an indicator of socioeconomic status (< 1 is high SES; 1.0 - 1.3 is middle; and > 1.3 is low).
Source: Cabelli and Dufour, 1983.

The results from the analysis of gastrointestinal (GI) illnesses indicated that, for children, Hispanics, and individuals from low to middle socioeconomic groups who swam at the BA beach, rates were significantly higher than among those who did not swim there (see Table 4).

TABLE 4. Analysis of Highly Credible Gastrointestinal (HCGI) Symptom Rates by Demographic Groups

Demographic Group	Symptom Rates per 1000 Persons			
	BA Beach[1] HCGI		RU Beach[1] HCGI	
	Swim	Nonswim	Swim	Nonswim
Total Sample	16	9.3	12	12
Children[2]	24[7]	4.5	9.2[7]	28.0
Adults[3]	13	11	12	9.5
High SES[4]	14[7]	5.2	15	10
Low SES[5]	21	17	9.1	13
Hispanic-Americans	21[7]	7.6	5.6	3.0
Non-Hispanic Americans[6]	10	11	9.1	13

[1] BA = barely acceptable; RU = relatively unpolluted
[2] Younger than 10 years old
[3] Older than 10 years old
[4] Ratio less than 1.0 persons/rooms
[5] Ratio greater than 1.0 person/rooms
[6] Black and white Americans
[7] Significantly different ($p < 0.05$) than nonswimming control
Source: Cabelli and Dufour, 1983.

Chemical Exposures

Fish consumption. Several studies have been conducted on fish consumption patterns by the U.S. population. These surveys have not provided adequate information for assessing health risks from chemicals among minority segments of the population whose consumption patterns may vary for economic or cultural reasons.

Consumption patterns in minorities. During 1985 and 1986, West (1989a) surveyed a group of Detroit residents who consumed fish from the Detroit River. Respondents were classified as white or nonwhite. He found that:

- whites tended to fish primarily for recreation, while non-whites tended to fish for both recreation and food;
- nonwhites with annual income between $5,000 and $20,000 had the highest consumption rate; and
- nonwhites consumed on average 2.5 times more grams/person/day than whites.

In 1988, West and coworkers (1989b) conducted a fish consumption survey of anglers with Michigan licenses. Again, they found that minority groups generally consumed more fish than whites (see Table 5).

TABLE 5. Fish Consumption (grams/person/day) by Race or Ethnicity in Michigan and California

Group	White	Black	Native American	Hispanic	Asian	Other
Michigan Anglers*	17.9	20.3	24.3	NR	NR	19.8
California Anglers**	46.0	24.2	NR	33	70.6	NR

NR = not reported
*Consumption rates are mean values. Source: West et al., 1989.
**Consumption rates are median values. Source: Puffer, 1981.

Puffer (1981) also looked at fish consumption patterns in minority populations in California and found that Asian fisherman have considerably higher consumption rates than white fishermen, and that rates for whites were higher than those for blacks (see Table 5).

The importance of using accurate patterns of fish consumption in assessing health risks from contaminants found in fish was emphasized by Foran et al. (1989). They calculated cancer risk projections for two contaminants of Great Lakes sport fish: DDT and dieldrin. Using three levels of fish consumption (i.e., 6.5, 32, and 96 g/day) and contamination levels near the FDA action level, they noted that estimated cancer risks could vary by as much as two orders of magnitude.

The State of Michigan's regulation that limits the discharge of toxic chemicals into Michigan surface waters (Rule 1057) was based on a risk assessment that assumed a fish consumption rate of 6.5 grams/person/day. However, West et al. (1989b) and Puffer (1981) indicate that average consumption rates by minority fishermen for sport and subsistence may be much higher.

Great Lakes and PCBs. Nearly 1,000 chemical substances have been identified in the Great Lakes aquatic environment (International Joint Commission, 1983). Analysis of cooked fish found high concentrations of polychlorinated biphenyls (PCBs) (Humphrey, 1988). PCBs are fat-soluble and sequester in the fat in the human body. Children can be exposed to PCBs before birth *in utero*, since PCBs can cross the placenta, and after birth in breast milk. The toxicological consequence of this multi-generational exposure is unknown. In another case study, Ransom (1990) examined a Superfund site on the St. Lawrence River that was responsible for contaminating fish and wildlife with PCBs. A midwife on the nearby Mohawk Reservation reported an increase in birth defects and miscarriages by pregnant women on the reservation. When fish and wildlife were subsequently examined, 3 -11,000 ppm PCBs were found in their tissues (FDA limit is 2 ppm). Fish and wildlife are a mainstay of the Mohawk's diet. The tribe was advised not to eat the local wildlife and fish more frequently than once a week. As a result of this advisory, many Mohawks have switched from a diet rich in protein to one that is primarily carbohydrate.

Nongame marine invertebrates. The Washington Department of Wildlife (Carney and Kvitek, 1991) found that, while most people collected marine invertebrates for "catch and replace," specific minority populations collected certain species for food: Moonsnails, and the crab *Cancer gracilis*. Over 50% of collectors who harvested invertebrates for food were Asian, Korean, or Filipino. Another Washington State Department of Social and Health Services report (McCallum, 1985) found that fishing and crabbing were traditional activities of many Asian cultures. Other reports state that some segments of the population eat fish or crustacean organs that may contain higher levels of chemical contaminants. Although many of the studies surveyed large minority populations, they failed to report, by minority status, ethnic or cultural trends in consumption of fish or crustacean organs.

Recreational waters. Ambient water quality has had impacts on minority health that cannot be easily established. Case reports or articles in newspapers and magazines draw public attention to potential problems, but these reports by themselves do not provide sufficient information on the existence of a problem. For example, on October 15, 1990, *Newsweek* reported that two of three children who frequently swam and caught crayfish in the Monte Santo bayou developed severe stomach aches that physicians could not explain, while the third child developed ovarian cancer. These children were reared in a black low-income housing project near Baton Rouge, Louisiana. Their mother suspects that the illnesses are related to toxic wastes that have been dumped into the bayou by petrochemical companies (De la Pena and Davis, 1990).

CASE STUDY: WATER QUALITY AND AVAILABILITY FOR NAVAJO FAMILIES LIVING ALONG THE PUERCO RIVER

Water is of great importance to Native Americans, for religious purposes as well as for practical purposes. Native American tribes have been deeply concerned about whether they have sufficient water to maintain their crops and livestock. In recent years, some communities have been faced with having to trade off water quality in order to have enough water to meet their basic needs. Increased development and population expansion on or near reservations have not only put a strain on the amount of water available, but have also lowered the quality of these waters (Lovato, 1983) and have threatened to contaminate sole sources of water (Judd et al., 1991).

An excellent example of the trade off between availability (quantity) and quality is the shore of the Puerco River, where approximately 14,000 Navajos live. Government figures from 1986 indicate that 40 to 50% of the valley's residents did not have running water in their homes. The large rural population of the valley remains dependent on sources of water that are either miles away or are nearby but unsafe to use (Shuey, 1986; Begay and Shuey, 1989). For many of these people, the Puerco River is a primary source of water for drinking, watering livestock, and irrigation.

The Puerco River is also the primary stream into which the area's uranium mining industry discharges its wastes. Between 1952 and 1981, activities associated with uranium mining in New Mexico resulted in the discharge of waste waters into the Puerco River that made the river flow all year long. Historically, the river has flowed for only a few days or weeks of the year and Native Americans have used that flow for watering livestock (Gallaher, 1983). In 1979, the Church Rock uranium mill released 94 million gallons of waste water containing acids, low-level radioactive materials, and toxic trace metals. The yellowish-green liquids flooded the bed of the Puerco along a 100-mile stretch of the river in two states. Native Americans, as well as their livestock who used the stream after the spill, were burned and injured (Begay and Shuey, 1989).

Following the collapse of the uranium market in the 1980s, many mines were shut down and abandoned. Because mine water is no longer discharged into the river, the most obvious effects of the spill are gone. However, the Puerco remains contaminated with high levels of radioactivity. Chemical analyses of samples taken from the Puerco River in New Mexico and Arizona indicated that concentrations of pollutants such as radium, lead, and selenium exceeded state and federal standards (Arizona Department of Health Services, 1985; Shuey and Morgan, 1987). The toxicity of the heavy metals and radionuclides found at the abandoned uranium mines also has been well documented (Budavari, 1989). The abandoned uranium mines are near well-defined drainages and shallow aquifers. Past mining practices, combined with the natural geology of the area, still present problems not only of water availability, but of water quality for the local Native American residents.

Uranium mining and its impact on local water quality is an issue faced by many Native American tribes. Half of the United States uranium reserves occur under reservation land. The other tribes hope that they will not be asked to become a "National Sacrifice Area" for energy and weaponry, as has the Puerco River region (Tolan, 1983).

CONCLUSIONS

This paper was discussed at a two day joint workshop sponsored by EPA, the National Institute for Environmental Health Sciences, and the Agency for Toxic Substances and Disease Registries, held at Durham, North Carolina, in August 1992. The discussion group included interested and affected researchers, educators, engineers, toxicologists, epidemiologists, and representatives of the public at large. To this group, there were clear discrepancies in rates of disease and death among the various ethnic and racial groups and among various socioeconomic groups as well. The group considered these observed disparities in relation to the role of environmental exposures to chemicals and microbes in water. The group drew the following conclusions:

1. *Despite the sparseness and limitations of the data, the existing data suggest that environmental inequities exist.* While the existing data do not support any broad

nationwide pattern of inequity, there are, however, clear situations where certain populations are exposed to higher levels of contaminants in water. What is not known is the effects of those high exposures and the total population experiencing those high exposures. There was even one example where higher exposures had been documented as had higher disease rates but no attempt to link the two was found. Another problem in analyzing the data is that the knowledge about exposure/health effect relationships of specific contaminants in any population are not known. Although data suggest that many of these groups may experience higher exposures, the possible effects of those exposures are unknown.

2. *Corrective action is possible under some circumstances.* Despite the absence of conclusive scientific evidence for environmental inequities in water contamination, there are situations where information is sufficient to take immediate corrective action. These situations include sanitary conditions associated with migrant farmworker colonies along the U.S.-Mexican border; and excessive exposure to hazardous waste in the four corners area of the Navajo reservation and other minority communities.

3. *The impact of populations not covered by the Safe Drinking Water Act is not known.* It is estimated that 40 million people are not covered by the SDWA. It is not known what proportion of these are minority and/or economically disadvantaged populations. Furthermore, little is known about the quality and availability of their drinking water.

4. *The role of infrastructure could not be assessed.* The status of the infrastructure for drinking water and wastewater treatment is unknown (e.g., whether infrastructure varies by minority or socioeconomic populations, whether infrastructure impacts the quality of water).

5. *Characteristics that affect exposure to water contaminants are unknown.* Differences in lifestyle, socioeconomic status, and culture may affect exposure to water contaminants. The nature of these differences has not been well studied, and their effect on exposure to water contaminants has not been ascertained.

6. *Education and communication need improvement.* There is inadequate communication between the scientific/regulatory community and minority and disadvantaged groups. Not only has the scientific/regulatory community failed to communicate to disadvantaged populations but disadvantaged populations have also failed to communicate their fears and concerns to the scientific/regulatory community. This lack of communication often means that these same disadvantaged communities do not have access to appropriate information. Even if information is available, they lack the education either to understand it or to take community-based action, including using proper consultants, that could change their circumstances.

RESEARCH RECOMMENDATIONS

Government and community organizations view environmental equity as a serious problem. There are several programs underway to aid disadvantaged groups. However, a strong scientific database and research program is needed to better understand the problem, to identify solutions to those problems, and to evaluate the efficacy of programs that address the problems. The work group offered the following research recommendations:

Databases

- Existing databases need to be analyzed for their value in assessing the exposure of populations to water contaminants, the health effects of those exposures, and the demographics of the populations exposed. The goal would be to compare racial, ethnic and socioeconomic groups as to differences in exposure and subsequent health effects.

- The development and collection of new data relating and defining minority exposures and health, needs to include total exposure assessment and assessment of risks from cross-media exposure and exposure to multiple agents.

- There is a need to determine whether minorities and economically disadvantaged people are more susceptible to adverse health effects from exposure to contaminated water.

Safe Drinking Water Act

- The quality of unregulated drinking water supplies needs to be determined, as does the percentage of minorities or economically disadvantaged persons who drink such water.

- The quality of water in small systems is often a matter of affordable technology. There is a need to develop inexpensive, easily managed technologies for treating water in small systems and individual facilities so that they provide safe drinking water.

Infrastructure

- A nationwide survey to determine the status of the infrastructure for drinking water systems in the United States is needed. Post treatment water distribution systems need to be examined and characterized, as does the availability and enforcement of plumbing codes (particularly residential applications of the codes).

- The effect of the infrastructure's status on water quality (biologic, chemical, or physical) needs to be determined. Whether the infrastructure's status is correlated with the demographics of its user population also needs to be determined.

Characteristics That Affect Exposure

- Both seasonal and yearly average patterns of water/fluid consumption need to be determined by gender, body weight, and age groups. This database should be able to differentiate the variability in patterns by race, ethnicity or economic status.

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- Cultural or lifestyle habits of consuming fish, parts of fish consumed, and other aquatic species consumed should be determined for all populations. These dietary habits may result in higher exposures to certain microbes and chemicals found in edible aquatic life.
- The impact of water quality regulations on people who subsist on fish needs to be determined, and alternative solutions to mitigate this impact need to be developed.
- The recreational swimming habits of minority and disadvantaged populations and the level of exposures to water contaminants through swimming need to be determined.
- The health implications of water usage and of its availability should be evaluated in those populations with limited water supplies.

Communication/Education

- Community-based, culturally sensitive educational programs should be developed and communicated to minority populations taking care to distinguish "information sources" from "education."
- Better ways for communicating with illiterate populations and with those who do not speak English as a first language should be devised.

SUMMARY

Minority and low socioeconomic populations experience higher rates of certain diseases. Life expectancy is shorter. Infant mortality is significantly higher than in the non-minority population. The role of environmental exposures in these higher disease rates is unknown. A considerable amount of research on the general population is being undertaken to help us better understand what needs to be done to correct some of our mistakes of the past and reduce potential problem areas in the future. It was not possible to extend the conclusions of the research directly to minority populations. What is needed is consideration of minority exposures, development of databases assessing water exposures and effects in all populations, research to eliminate the data gaps, and a research program to evaluate the efficacy of environmental equity programs. The fact remains, humans are increasingly being exposed to a vast array of contaminants discharged every day into our environment. We also know that few of these contaminants are good for us. We may not know just how bad they are for us. Water, its quality, quantity, and availability, affects many facets of our lives: from health and hygiene to cultural lifestyles, occupation choices, and geographic location. The role of water and its contaminants as a pathway for illnesses affecting the minority and the low socioeconomic populations should be examined and the implication that this knowledge has for the conduct of our environmental programs made clear to all.

ACKNOWLEDGEMENTS

The following people provided helpful suggestions for improving the manuscript: Roseanne Lorenzana (USEPA, Region X) and Arnold Kuzmack (USEPA/Office of Water).

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