Bottled Water
Pure Drink or Pure Hype?

Top of Report

Chapter 3

BOTTLED WATER CONTAMINATION: AN OVERVIEW OF NRDC'S AND OTHERS' SURVEYS

Setting aside the question of whether bottled water is as pure as advertised, is the public's view that bottled water is safer than tap water correct? Certainly the aggressive marketing by the bottled water industry would lead us to believe so.

NRDC undertook a four-year, detailed investigation to evaluate the quality of bottled water. We reviewed published and unpublished literature and data sources, wrote to and interviewed by phone all 50 states asking for any surveys of bottled water quality they have conducted or were aware of, and interviewed experts from FDA. In addition, through three leading independent laboratories, we conducted "snapshot" testing of more than 1,000 bottles of water sold under 103 brand names.

What NRDC has found is in some cases reassuring and in others genuinely troubling. The results of all testing NRDC conducted is presented in Appendix A; Figure 4 summarizes the results.

The bottled water industry generally has publicly maintained that there are no chemical contaminants in bottled water. For example, as noted in Chapter 2, a widely disseminated fact sheet on bottled water distributed by the International Bottled Water Association (IBWA) -- the industry's trade association -- states flatly that bottled water contains no chlorine or harmful chemicals. [75]

However, our investigation has found that potentially harmful chemical contaminants are indeed sometimes found in some brands of bottled water. *(The box at the end of this chapter highlights a particularly troubling example.)* NRDC's testing of more than 1,000 bottles of water (for about half of FDA-regulated contaminants; see the *Technical Report* [print report

only]), found that at least one sample of 26 of the 103 bottled water brands tested (25 percent) contained chemical contaminants at levels above the strict, health-protective limits of California, the bottled water industry code, or other states[3a] (23 waters, or 22 percent, had at least one sample that violated enforceable state limits). We found only two waters that violated the weaker federal bottled water standards for chemicals (in two repeat samples), and two waters that violated the federal standards for coliform bacteria in one test (though another batch of both of those waters tested clean for bacteria). The *Technical Report* (print report only) also discusses evidence provided by other investigators who in the past found that chemical contaminants were found in bottled water at levels violating the federal bottled water standards. [76]

Thus, in our limited bottled water testing, while strict health-protective *state* limits for chemicals sometimes were not met by about one fourth of the waters, the weaker *federal* bottled water standards generally were not violated. As noted in Table 2, among the chemical contaminants of greatest potential concern in bottled water are volatile organic chemicals, arsenic, certain other inorganic chemicals, and plastic or plasticizing compounds. Although most bottled water contained no detectable levels of these contaminants, or contained levels of the contaminants lower than those found in many major cities' tap water, we determined that one cannot assume on faith, simply because one is buying water in a bottle, that the water is of any higher chemical quality than tap water.

TABLE 2
Selected Contaminants of Potential Concern for Bottled Water

Contaminant	Health Concern with Excess Levels
Coliform Bacteria	Broad class of bacteria used as potential indicator of fecal contamination; may be harmless of themselves. Harmful types of coliform bacteria (such as certain fecal coliform bacteria or *E. coli*) can cause infections with vomiting, diarrhea, or serious illness in children, the elderly, and immunocompromised or other vulnerable people.
Heterotrophic Plate Count (HPC) Bacteria	Potential indicator of overall sanitation in bottling and source water; may be harmless of themselves. In some cases may indicate presence of infectious bacteria; data show sometimes linked to illnesses. Can interfere with detection of coliform bacteria or infectious bacteria. Unregulated by FDA.
Pseudomonas aeruginosa bacteria	Possible indicator of fecal contamination or unsanitary source water or bottling. Can cause opportunistic infections. Unregulated by FDA.
Arsenic	Known human carcinogen. Also can cause

	skin, nervous, and reproductive or developmental problems.
Nitrate	Causes "blue baby" syndrome in infants, due to interference with blood's ability to take up oxygen. Potential cancer risk.
Trihalomethanes (i.e., chloroform, bromodichloromethane, dibromochloromethane, and bromoform)	Cancer of the bladder, colorectal cancer, possibly pancreatic cancer. Also concerns about possible birth defects and spontaneous abortions.
Phthalate (DEHP)	Cancer; possible endocrine system disrupter. Unregulated by FDA.
Source: NRDC	

NRDC Testing Methodology

NRDC began during the summer of 1997 to test bottled water quality and continued testing or retesting some brands through early 1999. Our testing methodology is summarized in Table 3, and described in greater detail in the accompanying *Technical Report* (print report only). We conducted a four-pronged testing program, using three of the nation's most respected laboratories: two major independent commercial labs and one academic laboratory. In this four-pronged testing program, we tested water sold in the five states with the highest bottled water consumption in 1994 (California, Florida, Illinois, New York, and Texas), plus bottled water sold in the District of Columbia. [77] We tried to test major brands that held a significant percentage of the national or regional market share (for those brands for which market-share information was available), and we strove to purchase a variety of other brands and types of water, including the major bottled water products offered by some of the leading supermarket chains in the areas where the water was purchased.

The first prong of our survey was a preliminary screening of 37 California bottled waters in the summer and fall of 1997. The second involved detailed testing of 73 California waters in late 1997 and early 1998. The third was a survey of five bottled waters from each of five states other than California (a total of 25 waters) in late 1997 and early 1998. The final prong involved retesting more than 20 in which contamination had been found in earlier tests, which took place in mid- to late-1998 and early 1999.

We sampled the most waters from California, whose residents are by far the greatest consumers of bottled water in the nation. More bottled water is purchased in California than in the next five largest consuming states combined (see Figure 3). California generally has the most stringent standards and warning levels applicable to bottled water in the nation.

All of the labs we contracted with used standard EPA analytical methods for testing water. We conducted "snapshot" testing -- that is, we purchased several bottles of a single type of water, at a single location, and had those bottles tested. If we found a problem, we generally repurchased and then retested the water to confirm the earlier results. [78] Our testing methodology is summarized in Table 3, and described in greater detail in the accompanying *Technical Report* (print report only).

We asked the labs to use their standard contaminant test packages in order to control the total testing costs. In general, this meant that the labs tested for many of the most commonly found regulated contaminants, plus certain other contaminants that they could readily detect and quantify using the standard EPA methods and the analytical equipment they routinely use. Thus, some labs were able to detect more contaminants than others, though all tested for a core set of more than 30 regulated contaminants.

TABLE 3:
Summary of Lab Testing Protocols

Lab	# of Brands of Water Tested	Number of Contaminants Tested	General Testing Protocol	Comments
Environmental Quality Institute (Univ. N.C.)	37	41 regulated, over 40 unregulated	EPA analytical methods, single bottle sampled per contaminant type	Initial screening of California waters to determine whether more in-depth testing needed.
Sequoia Analytical	73	32 regulated, over 40 unregulated	EPA analytical methods, FDA protocol for sampling (test 1 composite sample of 10 bottles for chemical and microbial contaminants; 10 individual bottles tested for microbial follow-up if excess bacteria found in first round)	More extensive testing of California waters only.
National testing	25	57 regulated, over 200 unregulated	EPA analytical methods, FDA protocol for sampling (test 1 composite sample of 10 bottles; 10 individual bottles of all tested for	Testing of waters from 5 states outside of California (NY, FL, TX, IL, and DC).

			bacteria)	

Summary of Results of NRDC Testing

NRDC testing: the good news

First, the good news: Most brands of bottled water we tested were, according to our "snapshot" analyses of a subset of regulated contaminants, of relatively good quality (i.e., they were comparable to good tap water). Most waters contained no detectable bacteria, and the levels of synthetic organic chemicals and inorganic chemicals of concern for which we tested were either below detection limits or well below all applicable standards.

Caveats. This is not to say that all of these brands are without risk. One of the key limitations of the testing is that most tests were done just once or twice, so we could have missed a significant but intermittent problem. Numerous studies of source-water quality -- particularly surface-water sources and shallow groundwater sources -- demonstrate that source-water quality may substantially vary over time. [79] Operation, maintenance, or other mishaps at a bottling plant may cause periodic water-contamination problems that would not be detected by such "snapshot" tests. Thus, depending upon the bottler's source water, treatment technology (if any), and manufacturing, operation, and maintenance practices, some bottled waters' quality may vary substantially with time and with different production runs.

In addition, while we did test for dozens of contaminants at a cost of from about $400 to about $1,000 per type of water per round of testing (depending on the intensity of the testing), we were unable to test for many contaminants that may be of health concern. Thus, as is discussed in the accompanying *Technical Report* (print report only), we were unable to test for many kinds of bacteria, parasites, radioactivity, and toxic chemicals regulated by EPA and FDA in tap water or bottled water because such testing would have been even more expensive or difficult. Still, with those caveats, many bottled waters do appear to be of good quality, based on our limited testing.

NRDC testing: the bad news

For some other bottled waters, the story is quite different. The independent labs that conducted testing for NRDC found high levels of heterotrophic-plate-count bacteria in some samples, and in a few cases coliform bacteria (no coliforms were found in retests of different lots of the same water). The labs also found that some samples contained arsenic (a carcinogen) and synthetic organic chemicals (SOCs, i.e., man-made chemicals containing hydrogen and carbon), such as those contained in gasoline or used in industry. SOCs found included the probable human carcinogen phthalate (likely from the plastic water bottles), and trihalomethanes (cancer-causing by-products of water chlorination, which have been associated with birth defects and spontaneous abortions when found in tap water at high levels).[3b]

A detailed review of all our testing results and those of other investigators is presented in the

accompanying *Technical Report* (print report only), and the actual results for each brand of bottled water we tested are presented in Appendix A. In summary, our testing of 103 types of water found:

- **Violations of state standards.** At least one sample of about one fourth of the bottled waters bought in California (23 waters, or 22 percent) violated enforceable state limits (either bottled water standards or mandatory warning levels).

- **Violations of federal bottled water quality standards (coliform bacteria and fluoride).** Based on limited testing, four waters violated the weak federal bottled water standards (two for coliform bacteria that on retest contained no coliforms, and two for fluoride that were confirmed on retest to contain excessive fluoride). Coliform bacteria in water may not be dangerous themselves, but they are widely used as an indicator that may signal the presence of other bacteria or pathogens that could cause illness. Fluoride at excessive levels can cause mottling or dental fluorosis (pitting of teeth), skeletal fluorosis (adverse effects on bones), and cardiovascular and certain other health effects. [80]

- **Arsenic contamination.** Arsenic is a "known human carcinogen" when in drinking water; it also can cause many other illnesses, including skin lesions, nervous-system problems, and adverse reproductive and cardiovascular effects (the precise levels in drinking water necessary to cause these effects are the subject of heated debate). [81] Our testing found that one or more samples of eight waters (8 percent) purchased in California exceeded the 5 ppb warning level for arsenic set under California's Proposition 65, a law requiring public warnings if a company exposes people to excessive levels of toxic chemicals.[3c] (See Figure 5.)

- **Trihalomethane violations.** Trihalomethanes (THMs) are a family of chemicals created when chlorine is used to disinfect water (chlorine reacts with organic matter in the water to form THMs and other byproducts). Studies of people and animals exposed to THMs in their tap water have found elevated risks of cancer[82] and potentially a higher risk of spontaneous abortions and birth defects. [83] California has adopted a 10 ppb total THM limit, a standard recommended by the International Bottled Water Association (IBWA), the bottled water industry trade association. Twelve waters (12 percent) purchased in California had at least one sample that violated the state and IBWA bottled water standard for THMs in the same fashion. (See Figure 6.) Two waters sold in Florida exceeded the IBWA standard (Florida repealed its 10 ppb TTHM standard in 1997), and one sold in Texas violated the IBWA standard (Texas has not made the stricter 10 ppb standard enforceable). Chlorinated tap water also typically contains THMs (generally at levels above 10 ppb if the water is chlorinated), though many people who buy bottled water to avoid chlorine and its taste, odor, and by-products may be surprised to learn THMs are sometimes found in bottled water as well.

- **Excessive chloroform** Chloroform is the most common THM found in tap and bottled water; it is of particular concern because it is listed by EPA as a probable human carcinogen. Twelve waters purchased in California had at least one sample that exceeded the warning level for chloroform (a trihalomethane) set by California under Proposition 65, but they were sold without the required health warning (see Appendix A).

- **Excessive bromodichloromethane (BDCM).** BDCM is another THM that EPA has listed as a probable human carcinogen. Ten waters we bought in California that contained unlawful TTHM levels also had at least one sample that exceeded the Proposition 65 warning level for bromodichloromethane. These waters all were sold with no health warning that they contained BDCM at a level above the Proposition 65 level.

- **Excessive heterotrophic-plate-count (HPC) bacteria.** HPC bacteria are a measure of the level of general bacterial contamination in water. HPC bacteria are not necessarily harmful

themselves, but they can indicate the presence of dangerous bacteria or other pathogens and are used as a general indication of whether sanitary practices were used by the bottler. Nearly one in five waters tested (18 waters, or 17 percent) had at least one sample that exceeded the unenforceable microbiological-purity "guidelines" adopted by some states for HPC bacteria (500 colony-forming units, or cfu, per milliliter). (See Figure 7.) These states use unenforceable HPC-bacteria "guidelines" to measure bacterial contamination and sanitation. These state guidelines actually are weaker than voluntary HPC guidelines used by the industry trade association to check plant sanitation. (200 cfu/ml in 90 percent of samples taken five days after bottling), and are weaker than the European Union (EU) standard (100 cfu/ml, at bottling at 22 degrees Celsius).

- **Elevated nitrates, but at levels below standards.** Nitrates can be present in water as a result of runoff from fertilized fields or lawns, or from sewage; nitrates also may occur naturally, generally at lower levels. At elevated levels, nitrates can cause blue-baby syndrome -- a condition in infants in which the blood has diminished ability to take up oxygen, potentially causing brain damage or death; according to some, nitrates may be linked to cancer in adults. [84] The EPA and FDA standard for nitrates is 10 parts per million (ppm). There is spirited debate about whether these standards are sufficient to protect all infants in light of some studies suggesting ill effects at lower levels, [85] but both EPA and the National Research Council maintain that the current standard is adequate to protect health. [86] We found six bottled waters that had at least one sample containing more than 2 ppm nitrates; four of these had at least one sample containing more than 3 ppm nitrates (two contained up to 5.6 ppm nitrates in at least one test). (See Table 4.) Four of the six waters containing higher nitrate levels were mineral waters. The U.S. Geological Survey says that nitrate levels in excess of 3 ppm may indicate human-caused nitrate contamination of the water, [87] although it may be that some mineral waters naturally contain higher nitrate levels. To be safe, babies probably should not be fed with mineral water containing elevated nitrate levels.

TABLE 4
Selected Nitrate Levels Found in Bottled Waters

Bottled Water Brand	**Nitrate Level (as Nitrogen, in ppm)** *(First Test)*	**Nitrate Level (as Nitrogen, in ppm)** *(Subsequent Tests, If Any)*
Fiuggi Natural Mineral Water	2.5	
Hildon Carbonated Mineral Water	5.6	5.4
Hildon Still Mineral Water	5.6	
Perrier Sparkling Mineral Water	2.8, 2.6	4.3, 4.1
Sahara Mountain Spring Water	2.5	
Sparkling Springs	3.1	

Source: NRDC, 1997-1999

- **No fecal coliform bacteria or *Pseudomonas aeruginosa.*** Although, as noted previously, we did find total coliform bacteria in a few samples, no fecal coliform bacteria or *E. coli* bacteria were found. Earlier studies have found multiple species of the bacteria *Pseudomonas* in bottled water. [88] However, in an effort to control costs, we looked only for the species *Pseudomonas aeruginosa* and found none.

- **Synthetic organic chemicals at levels below enforceable standards.** About 16 percent of the waters (16 of 103) had at least one sample that contained human-made synthetic organic chemicals (SOCs) at levels below state and federal standards. The most frequently found SOCs were industrial chemicals (e.g., toluene, xylene, and isopropyltoluene), and chemicals used in manufacturing plastic (e.g., phthalate, adipate, and styrene). As discussed in the accompanying *Technical Report* (print report only), some of the chemicals found (such as phthalate) may pose health risks such as potential cancer-causing effects, even if present at relatively low levels. Generally, long-term consumption (over many years) is required to pose such chronic risks. The levels of these contaminants found in our testing are indicated in Table 5.

- **Overall contamination findings** Overall, at least one sample of about one third of the tested waters (34 waters, or 33 percent) contained significant contamination (i.e., contaminants were found at levels in excess of standards or guidelines). This is not simply the sum of the waters that violate enforceable standards plus those that exceeded guidelines, as some waters violated both.

- The detailed results of our testing for each type of water are presented in the *Technical Report* (print report only). As is discussed there, testing by states and by academic researchers have also sometimes found the contaminants we studied or other potentially toxic and infectious agents in some brands of bottled water.

TABLE 5
Selected Synthetic Organic Compounds (Other Than THMs) in Bottled Water

Bottled Water (& State of Purchase)	Xylene Level (ppb)	Toluene Level (ppb)	Other VOCs Found (in ppb)	Comments
Alhambra Crystal Fresh Drinking Water (CA)	2.7 (test 1) 0 (test 2)	12.5 (test 1) Not Detected (test 2)	Not Detected (tests 1 & 2)	Xylene and toluene below FDA & CA standards, but presence could indicate treatment standard violation.
Black Mountain	Not	8.9 (test	Not Detected	Toluene below

Spring Water (CA)	Detected (tests 1-3)	1) Not Detected (tests 2 & 3)	(tests 1 & 2)	FDA and CA standards, but presence could indicate treatment standard violation.
Lady Lee Drinking Water (Lucky, CA)	2.9 (test 1) Not Detected (test 2)	11.0 (test 1) 0.5 (test 2)	Not Detected (tests 1 & 2)	Xylene and toluene below FDA & CA standards, but presence could indicate treatment standard violation.
Lady Lee Natural Spring Water (Lucky, CA)	3.0 (test 1) Not Detected (test 2) 0 (test 3)	13.9 (test 1) Not Detected (test 2) 0.5 (test 3)	Not Detected (tests 1 & 2)	Xylene and toluene below FDA & CA standards, but could indicate CA treatment standard violation.
Lady Lee Purified Water (Lucky, CA)	9.4 (test 1) Not Detected (test 2)	9.5 (test 1) Not Detected (test 2)	Ethylbenzene 2.0 ppb (test 1) Ethylbenzene not detected (test 2) Ethylbenzene not detected (test 3) Methylene Chloride 4.1 ppb (test 3)	Xylene, toluene, methylene chloride, and ethylbenzene below FDA & CA standards, but could indicate CA treatment standard violation. Methylene chloride standard is 5 ppb.
Lucky Sparkling Water (w/raspberry)(CA)	Not Detected	Not Detected	p-isopropyltoluene 5.4 ppb	Single test; no standard for p-isopropyltoluene.
Lucky Seltzer Water (CA)	Not Detected (tests 1 & 2)	Not Detected (test 1) 1.8 (test 2)	n-isopropyltoluene at 230 ppb (test 2) n-butylbenzene at 21 ppb (test 2)	Source of elevated level of n-isopropyltoluene and of n-butylbenzene contamination

			Neither detected in test 1	unknown; no standards apply.
Dannon Natural Spring Water (NY)	Not Detected (tests 1-3)	Not Detected (tests 1-3)	Methylene chloride at 1.5 ppb (test 3) Methylene chloride not detected in tests 1 & 2	FDA's Methylene chloride (dichlormethane) standard is 5 ppb.
Nursery Water (CA)	3.2 (test 1) Not Detected (test 2)	12.4 (test 1) 0.6 (test 2)	Styrene 3.0 (test 1) Not Detected (test 2)	Xylene, toluene, and styrene below FDA & CA standards, but could indicate CA treatment standards violation.
Perrier Mineral Water (CA)	Not Detected (tests 1-3)	Not Detected (tests 1-3)	2-Chlorotoluene 4.6 ppb (test 1) 2-Chlorotoluene 3.7 ppb (test 2) 2-Chlorotoluene Not Detected (test 3)	No standard for 2-chlorotoluene; contamination from unknown source.
Polar Spring Water (DC)	Not Detected	2.5	Not Detected	Toluene detected at level below FDA standard (single test).
Publix Drinking Water (FL)	Not Detected (tests 1-3)	Not Detected (tests 1-3)	Acetone 11 ppb (test 1) Acetone 14 ppb (test 2) Acetone 16 ppb (test 3) Styrene 0.6 ppb (test 1) (No styrene found tests 2-3)	Styrene found at level well below EPA Health Advisory level; no standard or Health Advisory for acetone.
Publix Purified Water (FL)	Not Detected	Not Detected	Styrene 0.2 ppb	Styrene found at level well below EPA Health Advisory level (single test).
Safeway Purified Water (CA)	Not Detected	8.4 (test 1)		Toluene detected at level below

	(tests 1 & 2)	Not Detected (test 2)		FDA and state standard, but could indicate CAtreatment standard violation.
Safeway Spring Water (CA)	3.1 (test 1) Not Detected (test 2)	14.2 (test 1) Not Detected (test 2)		Xylene and toluene below FDA & CA standards, but could indicate CAtreatment standard violation.
Safeway Spring Water (DC)	Not Detected	4.7		Single test, toluene below FDA standard.
Source: NRDC 1997-1999				

Other Surveys of U.S. Bottled Water Quality

Relatively little information about bottled water quality is readily available to consumers. Few surveys of bottled water quality have been conducted in the United States during the past four years, and fewer still are widely available.

A handful of state governments have done surveys in recent years. Kansas has done a small survey of certain waters sold in the state, [89] Massachusetts prepares an annual summary of industry testing of waters sold in that state, [90] and New Jersey issues an annual summary, primarily of industry testing of water sold there. [91] In addition, Pennsylvania periodically issues a small state survey of waters sold locally, [92] and Wisconsin issues a small annual testing of about a dozen state waters. [93] In general, these states have reached conclusions similar to those we have reached: that most bottled water is of good quality but that a minority of the bottled water tested contains contaminants such as nitrates or synthetic organic chemicals, in a few cases at levels of potential health concern. These surveys are summarized in detail in the *Technical Report* (print report only).

A few academicians have published papers focusing on bottled water contamination from specific types of contaminants. For example, academic studies have focused on *Pseudomonas* bacteria in various brands of bottled water, [94] the leaching of chemicals from plastic manufacturing (such as phthalates) [95] from plastic bottles into the water, or contamination of bottled water with certain volatile synthetic organic compounds. [96] The researchers often tested only a relatively small number of brands of water, or failed even to name which bottled water was tested, making the information of limited value to consumers seeking to select a brand of water that is uncontaminated. Comprehensive studies of Canadian bottled waters also have been published -- without naming the brands with problems. The results of many of these studies are in the *Technical Report* (print report only), which presents in greater detail the evidence of microbiological and chemical contamination

of bottled water.

Potential for Disease from Bottled Water

As is discussed in the accompanying *Technical Report* (print report only), there is no active surveillance for waterborne disease from tap water in the United States, nor is there active surveillance of potential disease from bottled water. There are certain "reportable" diseases, such as measles, which are reportable to CDC and state health departments, and for which there is active surveillance. Most diseases caused by organisms that have been found in bottled water, however, are not reportable, and in any event may come from a variety of sources, so the amount of disease from microbiologically contaminated bottled water (or tap water) is unknown. Thus, since no one is conducting active surveillance to determine if waterborne illnesses are occurring, even if waterborne illness from bottled water were relatively common, it would be unlikely that it would be noticed by health officials unless it reached the point of a major outbreak or epidemic.

There are cases of known and scientifically well-documented waterborne infectious disease from bottled water, but most have occurred outside of the United States (see *Technical Report* [print report only] and Appendix B). However, there clearly is a widespread potential, according to independent experts, for waterborne disease to be spread via bottled water. [97]

Bottled Water and Vulnerable Populations

Many people who are especially vulnerable to infection (such as the infirm elderly, young infants, people living with HIV/AIDS, people on immunosuppressive chemotherapy, transplant patients, etc.) use bottled water as an alternative to tap water out of concern for their safety. Some leading public-health experts, therefore, argue that bottled water should be of higher microbiological quality than most foods. [98] In fact, health-care providers and other professionals often recommend that people who are immunocompromised or who suffer from chronic health problems drink bottled water. Indeed, FDA's guidance for immunocompromised people (posted on the FDA Web site) recommends that people with lowered immunity should "drink only boiled or bottled water. . . ." [99]

Immunocompromised people often are not aware of the need to ensure that they are drinking microbiologically safe water or are vaguely aware of this issue but simply switch to bottled water on the assumption that it is safer than tap water. As discussed previously and in detail in the accompanying *Technical Report* (print report only), this may not be a safe assumption.

Bottled Water Storage and Growth of Microorganisms

Bottled water often is stored at relatively warm (room) temperatures for extended periods of time, generally with no residual disinfectant contained in it. As noted in the *Technical Report* (print report only) and shown in Figure 8, several studies have documented that there can be

substantial growth of certain bacteria in bottled mineral water during storage, with substantial increases in some cases in the levels of types such as heterotrophic-plate-count-bacteria and *Pseudomonas*. [100] Studies also have shown that even when there are relatively low levels of bacteria in water when it is bottled, after one week of storage, total bacteria counts can jump by 1,000-fold or more in mineral water. [101]

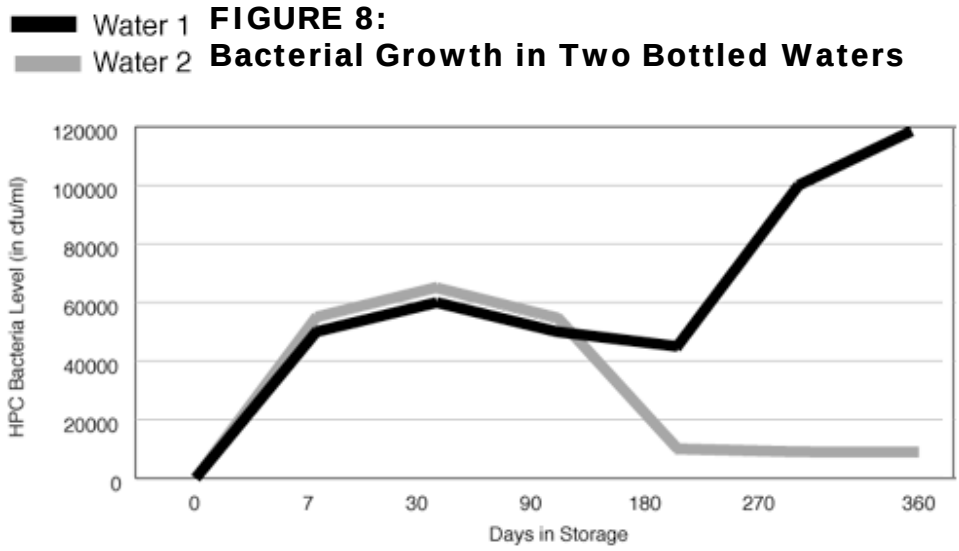

FIGURE 8: Bacterial Growth in Two Bottled Waters

Source: Adapted from P.V. Morais and M.S. Da Costa, "Alterations in the Major Heterotrophic Bacterial Populations Isolated from a Still Bottled Mineral Water," *J. Applied Bacteriol,* v. 69 pp. 750-757, Figure 1 (1990).

Conclusions Regarding Bottled Water Contaminants

Our limited "snapshot" testing, and that published in a few other recent surveys of bottled water, indicate that most bottled water is of good quality. However, our testing also found that about one fourth of the tested bottled water brands contained microbiological or chemical contaminants in at least some samples at levels sufficiently high to violate enforceable state standards or warning levels. About one fifth of the brands tested exceeded state bottled water microbial guidelines in at least some samples. Overall, while most bottled water appears to be of good quality, it is not necessarily any better than tap water, and vulnerable people or their care providers should not assume that all bottled water is sterile. They must be sure it has been sufficiently protected and treated to ensure safety for those populations.

AN EXAMPLE OF INDUSTRIAL-SOLVENT CONTAMINATION OF BOTTLED WATER
[102]

One particularly troubling case of industrial-chemical contamination of bottled water arose in Massachusetts. Massachusetts Department of Public Health files reveal that the Ann & Hope commercial well in Millis, Massachusetts, for years supplied several bottlers, including Cumberland Farms, West Lynn Creamery, Garelick Farms, and Spring Hill Dairy with "spring water" sold under many brand names.

According to state officials and records, this well is located literally in a parking lot at an industrial warehouse facility and is sited near a state-designated hazardous-waste site. Several chemical contaminants were found in the water, including trichloroethylene (an EPA-designated probable human carcinogen). On at least four occasions these chemicals were found at levels *above* EPA and FDA standards in the well water. Dichloroethane, methylene chloride, and other synthetic organic chemicals (industrial chemicals) were also found, though the source of these contaminants reportedly was not identified.

Contamination was found in the water in 1993, 1994, 1995, and 1996, but according to a state memo written in 1996, "at no time did Ann & Hope [the well operating company] do anything to determine the source of the contamination nor treat the source. Rather, they continued to sell water laced with volatile organic compounds, some of which were reported in finished product." The contamination levels depended on pumping rates from the wells. After a state employee blew the whistle on the problem and demanded better protection of bottled water in the state, she was ordered not to speak to the media or bottlers and was reassigned by Massachusetts Department of Public Health supervisors to other duties, in what she alleges was a retaliatory action. State officials deny that her reassignment was due to retaliation. The

well reportedly is no longer being used for bottled water after the controversy became public.

Chapter Notes

3a. For cost reasons, we did not test for any radiological contaminants.

3b. Throughout this report and the attached Technical Report (print report only) we refer to two categories of chemicals for which we tested, semivolatile synthetic organic chemicals and volatile organic chemicals (VOCs). Technically, synthetic organic chemicals (SOCs) include any man-made chemicals—including nonvolatile, semivolatile, and volatile—that contain hydrogen and carbon. We, EPA, and FDA refer to VOCs as a shorthand for volatile synthetic organic chemicals, and to semivolatile SOCs as separate types of chemicals, even though many VOCs are also a type of SOC. The reason for differentiating between these two categories of contaminants is that EPA standard methods for testing for them are different, and because both EPA and FDA rules tend to artificially distinguish between VOCs and SOCs—the later being shorthand for semivolatile SOCs.

3c. None of the waters we tested exceeded the FDA and EPA standard for arsenic in water of 50 ppb. That standard originally was set in 1942 and is 2,000 times higher than the level EPA recommends for ambient surface water for public-health reasons; it also is 5 times higher than the World Health Organization and European Union arsenic-in-drinking-water limit. Congress has required that the EPA standard be updated by the year 2001. For reasons discussed in the accompanying Technical Report (print report only), many public health, medical, and other experts believe that the current EPA/FDA standard is far too high.

Report Notes

75. IBWA, "FAQs [Frequently Asked Questions] About Bottled Water," (1998); available at www.bottledwater.org/faq.html#3.

76. See, e.g., "The Selling of H2O," Consumer Reports, p. 531 (September 1980),.(finding excessive arsenic in several waters); "Water, Water Everywhere," *Consumer Reports*, pp. 42-48 (January 1987), (also finding excessive arsenic in several waters); see also, "Bottled Water Regulation," Hearing of the Subcommittee on Oversight and Investigations of the House Committee on Energy and Commerce, Serial No. 102-36, 102nd Cong., 1st Sess. 5, (April 10, 1991), (noting excessive benzene and other contaminants in bottled water).

77. According to figures for 1994 collected by the Beverage Marketing Corporation, the leading states were, in order, California (about 30% of the market), Florida (about 6%), New York (about 6%), Texas (about 6%) and Illinois (about 4%). Beverage Marketing Corporation, *Bottled Water in the U.S.* , 1996 Edition (1996), as cited in New Jersey Department of Health & Senior Services, *Report to the New Jersey Legislature, Summarizing Laboratory Test Results on the Quality of Bottled Drinking Water for the Period January 1, 1995 through December 31, 1996*, p. 6 (July 1997). A more recent survey found "California remains the top market for bottled water, with four times the number of gallons sold as the second-largest market. In fact, Californians drank 893,700 gallons of bottled water in 1997, more than the next four states combined: Florida (221,700 gallons), Texas (218,700), New York (204,400), and Arizona (124,900)." C. Roush, "Bottled Water Sales Booming," *The Daily News of Los Angeles*, p. B1 (April 16, 1998).

78. In a handful of cases, water was found in a test to contain contamination at levels of potential concern, but not retested -- generally because the water could not be found for retesting or it was logistically impractical to repurchase and reship the water for retesting. (See Appendix A.)

79. For example, the U.S. Geological Survey's (USGS) National Water Summaries (see, e.g. USGS, *National Water Summary*, 1988-1996), and National Water Quality Assessment Program (see, e.g., USGS *National Water Quality Assessment Program--Pesticides in Ground Water* (1996), USGS *National Water Quality Assessment Program -- Pesticides in Surface Water (1997);* see also www.usgs.gov (amply document that water quality measured using pesticides or other

indicator contaminants can vary by orders of magnitude in a stream or shallow groundwater in some areas, depending upon the time of year, chemical use, hydrologic events such as precipitation, etc.)

80. See, U.S. Public Health Service, Department of Health and Human Services, *Review of Fluoride: Benefits and Risks* (February 1991); B. Hileman, "Fluoridation of Water: Questions About Health Risks and Benefits Remain After More than 40 Years," *Chemical & Engineering News*, pp. 26-42 (August 1, 1988); Robert J. Carton, Ph.D., and J. William Hirzy, Ph.D., EPA, and National Treasury Employees Union, "Applying the NAEP Code of Ethics to the Environmental Protection Agency and the Fluoride in Drinking Water Standard," *Proceedings of the 23rd Annual Conference of the National Association of Environmental Professionals*; 24 June 1998, San Diego, California, Sponsored by the California Association of Environmental Professionals, available at http://home.cdsnet.net/~fluoride/naep.htm.

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83. *See*, S.H. Swan, et al., "A Prospective Study of Spontaneous Abortion: Relation to Amount and Source of Drinking Water Consumed in Early Pregnancy," *Epidemiology*, vol. 9, no. 2, pp. 126-133 (March 1998); K. Waller, S. H. Swan, et al. (1998). "Trihalomethanes in Drinking Water and Spontaneous Abortion," *Epidemiology*, vol. 9, no. 2, pp. 134-40 (1998); F. J. Bove, et al. "Public Drinking Water Contamination and Birth Outcomes," *Amer. J. Epidemiol.* , vol. 141, no. 9, pp. 850-862 (1995); *see also*, NRDC, U.S. PIRG, and Clean Water Action, *Trouble on Tap: Arsenic, Radioactive Radon, and Trihalomethanes in Our Drinking Water* (1995).

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102. The information in this text box is summarized from the Massachusetts Department of Public Health's (MDPH) Ann & Hope Water Incident Files, 1993-1997, including MDPH, *Survey of Massachusetts Bottlers for Source and Finished Product Contamination* (1992-1997); *Summary of the Amount of Water Withdrawn from the Millis Springs, Inc. Spring* #2 (undated); Letter from Dr. Elizabeth Bourque to J. McKinnies, Ann & Hope (August 7, 1996); Memorandum From Dr. Bourke to Paul Tierney, December 13, 1996 (MDPH Memoranda Provided to NRDC Pursuant to Freedom of Information Request); D. Talbot, "Bottled Water Flows from Troubled Well," *Boston Herald*, p. 1 (December 16, 1996); E. Leuning, "Toxin in Ann & Hope Wells Worries Officials," *Middlesex News*, p. 1 (September 18, 1996); E. Leuning, and H. Swails, "Water Source has History of Contaminants," *Country Gazette* (September 18, 1996); Personal Communication with Dr. Bourque, MDPH, August 1997, and January 1999; Personal Communication with Paul Tierney, MDPH, January 1999.

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Parks
Wilderness Preservation
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