HOUSTON, TX

Note: This city summary focuses on the main drinking water system located in Harris County in Houston. There are at least four other municipal systems serving the Houston area, but these were not included in the analysis (except where indicated).

Houston's Main Drinking Water System Earned a Water Quality and Compliance Grade of Poor in 2000 and Fair in 2001

Arsenic, haloacetic acids, and total trihalomethanes were found in Houston's groundwater at levels of concern; radon at levels of serious concern.

▶ Houston had no reported violations of currently enforceable national standards in 2000–2001, other than a monitoring violation in 2001.[1]

▶ **Haloacetic acids (HAAs) and total trihalomethanes (TTHMs),** by-products of chlorine disinfection that may cause cancer and reproductive and other health problems, occurred at levels of concern in Houston. HAA levels reported in 2000 (measured in 1998) were higher than is permitted under a new national standard that went into effect in 2002; levels improved in 2001.

▶ **Radon,** a radioactive gas known to cause cancer, is a serious concern in Houston's wells, where average radon levels are more than double the proposed national standard. However, because radon is a gas, Houston contends (without providing data) that the radon dissipates before it reaches the tap.

▶ Drinking water in Houston's wells contained average **arsenic** levels of half the new national standard, but arsenic levels in some wells peaked at nearly double the new national standard (effective in 2006). Arsenic—the product of mining and industrial processes, past use of arsenic-containing pesticides, and natural leaching or erosion from rock—is a known and potent human carcinogen that has been linked to a variety of other diseases.

▶ About 2 to 3 percent of Houston's peak monthly samples contained **total coliform bacteria,** microbial contaminants whose presence is a potential indicator that disease-causing organisms may be present in tap water. The national standard allows up to 5 percent.

▶ Houston had a **monitoring violation** in 2001 because the city water system did not take enough test samples; the city also failed to report the infraction.

HOUSTON
System Population Served **2,354,040**[2]
Water Quality and Compliance **2000▶Poor** **2001▶Fair**
Right-to-Know Report—Citizenship **2000▶Poor** **2001▶Fair**
Source Water Protection **Poor**
REPORT CARD

Houston's Right-to-Know Reports Earned a Grade of Poor for 2000 and Fair for 2001

▶ The reports included prominent placement of the mandatory special alert for people who are more vulnerable to particular contaminants, they included information on unregulated contaminants, and they included a sentence in Spanish urging Spanish-speaking consumers to obtain more information in their native tongue from the city.

▶ The 2000 report provided a prominent and incorrect description of arsenic's health threat, and both reports offered misleading information about *Cryptosporidium,* which has been found in Houston's source water.

Houston Earned a Source Water Protection Rating of Poor

▶ Two-thirds of the drinking water provided to Houston residents comes from the San Jacinto and Trinity Rivers. These rivers are vulnerable to pathogen and pesticide pollution, urban runoff, and agricultural runoff. Houston's groundwater supplies the balance of the water supply, and it is also, in some cases, vulnerable to contamination.

Noteworthy

▶ Houston has identified $680 million in drinking water projects that are needed over the next five years to assure continued adequate water quality and supply in the city. Among the major necessary projects are a $140 million upgrade in surface transmission lines, $119 million for

water main refurbishments, and $101 million for expansions, upgrades, and optimization of two drinking water treatment plants. Other projects include construction and rehabilitation of storage tanks.[3]

KEY CONTAMINANTS IN HOUSTON'S WATER

The following contaminants have been found in Houston's drinking water supply. For more information on health threats posed by specific contaminants, see Chapter 5.

MICROBIOLOGICAL CONTAMINANTS

Houston's Drinking Water Monitoring Violation for Potential Indicator of Microbial Problems

Under the EPA's Surface Water Treatment Rule (SWTR), Houston is required to sample regularly a variety of parameters in its water to ensure that filters are working properly and to verify removal of microbial disease-causing organisms like *Giardia* and *Cryptosporidium.* In June 2001, Houston incurred a routine monitoring violation of the SWTR; the city then failed to report that violation, which constitutes yet another violation (a public notice violation).[4] A minor SWTR monitoring violation occurs when the water system takes at least 90 percent of required water samples but fails to take the full number required under the rule. Houston had no other recent reported violations of current, pending, or proposed standards.[5]

Cryptosporidium

National Standard (MCL)
Treatment Technique (TT)

Draft Proposed New National Standard[6]
<7.5 organisms/100 liters (average); no additional treatment
7.5–100 organisms/100 liters (average); some additional treatment (>90% *Crypto* kill)
100–300 organisms/100 liters (average); significant additional treatment (>99% *Crypto* kill)
>300 organisms/100 liters (average); advanced treatment (>99.7% *Crypto* kill)

National Health Goal (MCLG)
0—no known fully safe level

National Requirements
Most large- and medium-size water utilities that use surface water are required to monitor for *Crypto* and report results in their right-to-know reports; they eventually may be required to use advanced treatment if significant levels are found.

1997–1998 levels
Source water (before treatment)
0—185 oocysts/100 liters[7]

Tap Water (Finished, After Treatment)
No confirmed occurrences[8]

LEVELS PRESENT HIGH CONCERN

Cryptosporidium (*Crypto*) is a waterborne microbial disease-carrying pathogen that presents health concerns, especially to individuals with weakened immune systems, including HIV/AIDS patients, the elderly, children, and people who have undergone organ transplants. Under a negotiated EPA rule that is out in draft proposed form and is soon scheduled to be proposed formally in *The Federal Register,* water utilities that find significant levels of *Crypto* will have to use a more effective treatment to kill the pathogen.

Houston generally reported finding no *Crypto* in its source water during 18 months of monthly monitoring in 1997 and 1998—with the important exception of a high finding of 185 oocysts/100 liters in August 1997. *Crypto* is extremely difficult to detect in finished (treated) drinking water, so it was no surprise that the city has not found *Crypto* in its treated water. The detection of *Crypto* at such an elevated level in the city's source water is of concern; more comprehensive monitoring (particularly more frequent and targeted monitoring at times of maximum likelihood of occurrence) is warranted. While well-calibrated filtration is likely to remove most *Crypto*, additional steps—such as use of a disinfectant like ozone or ultraviolet light—would reduce the chances of any problem in the event of a filtration plant breakdown.

Total Coliform Bacteria

National Standard (MCL)
5% maximum in any month[9]

National Health Goal (MCLG)
0—no known fully safe level

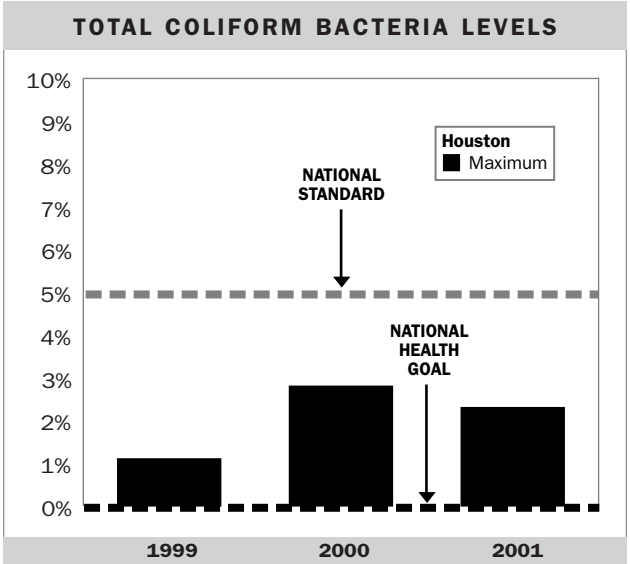
1999 Levels
1.1% in highest month, total coliform positive[10]

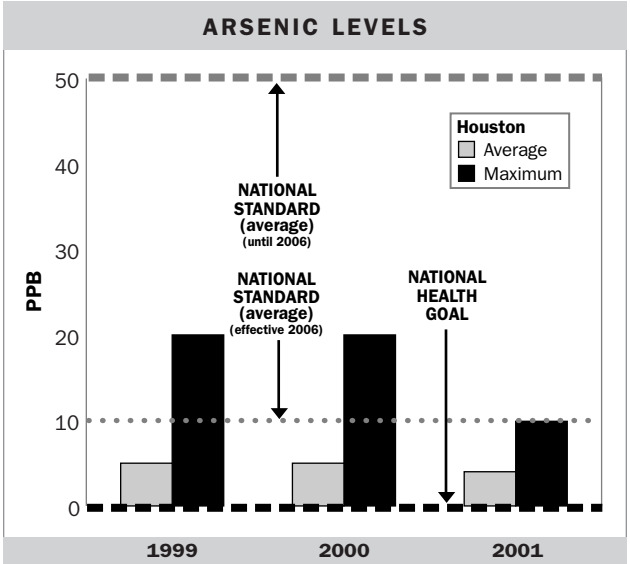
2000 Levels
2.8% in highest month, total coliform positive[11]

2001 Levels
2.3% in maximum month, total coliform positive[12]

LEVELS PRESENT SOME CONCERN

Total coliform bacteria are microbial contaminants whose presence is a potential indicator that disease-





causing organisms may be present in tap water. Nearly 3 percent of Houston's monthly samples contained total coliform bacteria during the peak month in 2000; the EPA's standard allows up to 5 percent. So while the findings did not exceed the standard, they still indicate possible problems with regrowth of bacteria in Houston's water mains. In the Spanish Cove area, more than 16 percent of samples contained coliform; this finding would have represented a violation were this a free-standing water system.

INORGANIC CONTAMINANTS

Arsenic

National Standard (MCL)
50 ppb (average) effective through 2005
10 ppb (average) effective in 2006

National Health Goal (MCLG)
0—no known fully safe level

	Average	Maximum[13]
1999 Levels	5 ppb	20 ppb (groundwater)
2000 Levels	5 ppb	20 ppb (groundwater)
2001 Levels	4 ppb	9.9 ppb (groundwater)

LEVELS PRESENT HIGH CONCERN

Arsenic—the product of mining and industrial processes, past use of arsenic-containing pesticides, and natural leaching or erosion from rock—is a known and potent human carcinogen that has been linked to a variety of other diseases. While most or all areas within the city limits of Houston apparently will be able to comply with the EPA's new arsenic standard, a survey by the *Houston Chronicle* indicated that 36 of 123 Houston-area water systems (generally outside city limits) need to lower their arsenic levels to be in compliance with the new standard.[16] Arsenic was not detected in Houston's surface water supplies, which provide two-thirds of the city's water.

Lead

National Standard (TT)
15 ppb (action level, at 90th percentile)[17]

National Health Goal (MCLG)
0—no known fully safe level

1999 levels (most recent data reported)[18]
5 ppb at the 90th percentile home; one home tested exceeded the national standard

LEVELS PRESENT SOME CONCERN

Lead—which enters drinking water supplies from the corrosion of pipes or faucets—can adversely affect blood pressure, red blood cells, and kidney and nervous system function and, especially in infants and children, cause permanent brain damage, decreased intelligence, and problems with growth, development, and behavior. Although in general lead in tap water does not appear to be a serious problem in Houston, parents of young infants and children may wish to have their tap water tested for lead, since levels can vary enormously from house to house, depending upon local water service lines, meters, household

plumbing, and other factors. To find a laboratory, contact the Drinking Water Hotline, 800-426-4791. Or consumers may choose to flush faucets of lead by running water for approximately one minute before ingestion. (Excess water may be saved for plants or other uses.)

ORGANIC CONTAMINANTS

Haloacetic Acids

National Standard (MCL)
60 ppb (average) effective in 2002; no previous standard

National Health Goal (MCLG)
0—no known fully safe level[19]

1998 Levels[20]	Average
East Plant I & II (surface water)	57.3 ppb
East Plant III (surface water)	60.5 ppb
Southeast Plant (surface water)	34.6 ppb
Katy Addicks Plant (groundwater)	5.4 ppb

2001 Levels[21]	Average
East Plant I & II (surface water)	30.5 ppb
East Plant III (surface water)	31.4 ppb
Southeast Plant (surface water)	32.3 ppb
Katy Addicks Plant (groundwater)	7.2 ppb

LEVELS PRESENT HIGH CONCERN

Haloacetic acids (HAAs), by-products of chlorine disinfection, may cause cancer and, potentially, reproductive and other health problems. Chlorinated surface water in Houston appeared to have haloacetic acid at levels of concern until 2001. In 1998, drinking water entering the Houston distribution system from East Plants I and II contained average levels of haloacetic acids above the new maximum allowable amount, which was finalized in 1998 but first enforceable in 2002. By 2001, the HAA levels apparently were reduced to about half of the new standard. At these levels, there is much less concern about possible health effects, although according to the EPA there is still some cancer risk from some HAAs at any level above 0.

Total Trihalomethanes

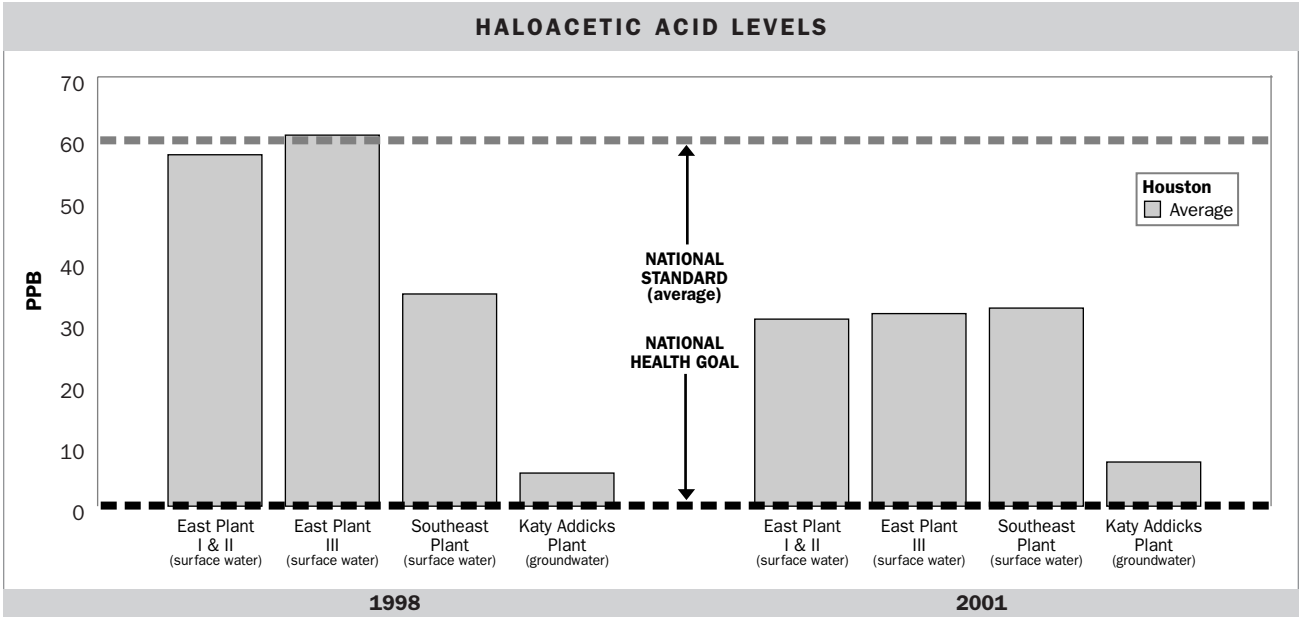
National Standard (MCL)
100 ppb (average) effective through 2001
80 ppb (average) effective in 2002

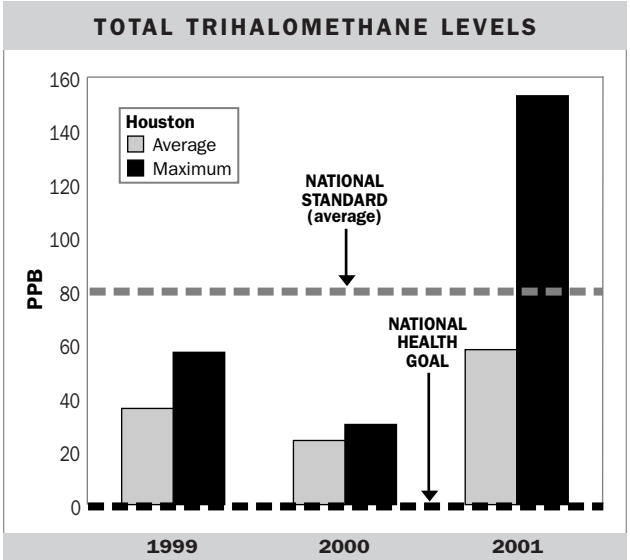
National Health Goal (MCLG)
0—no known fully safe level[22]

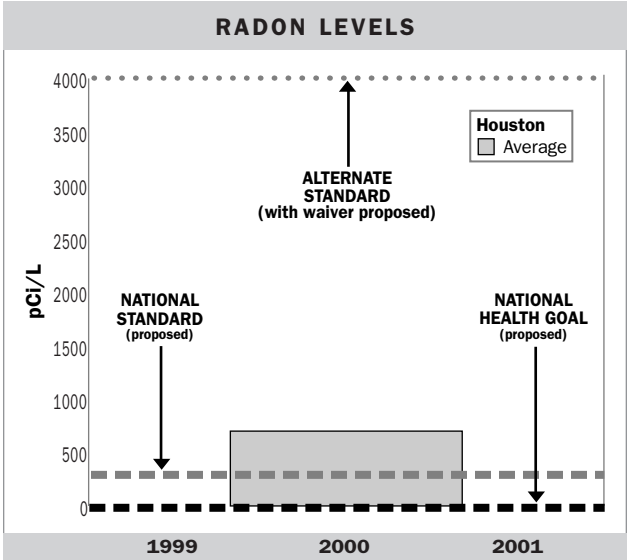
1999 Levels	Average	Maximum
	36 ppb[23]	57 ppb[24]
2000 Levels	Average	Maximum
	24 ppb[25]	30 ppb[26]
2001 Levels[27]	Average	Maximum
	58 ppb[28]	153 ppb

LEVELS PRESENT HIGH CONCERN

Total trihalomethanes (TTHMs)—contaminants that result when chlorine is used to treat drinking water and then interacts with organic matter in the water—are linked with cancer and, potentially, to miscarriages and birth defects. Houston's disinfection







by-product levels are similar to the levels in many cities that use surface waters and do not violate the EPA's new standard, which is based on average levels. However, at times TTHMs have spiked to high levels—reportedly as high as 153 ppb in 2001—that are nearly double the new health standard and present possible health concerns.

RADIOACTIVE CONTAMINANTS

Radon

National Standard (MCL) (proposed)
300 pCi/L (average)
Alternate MCL of 4,000 pCi/L where approved multimedia program is in place (average)

National Health Goal (MCLG) (proposed)
0—no known fully safe level

2000 Levels
Average: 700 pCi/L at wellhead[29]

VIOLATION OF PROPOSED STANDARD

Radon, which results from the natural radioactive breakdown of uranium in the ground, is a radioactive gas known to cause lung and internal organ cancers. Houston's radon levels in well water average more than twice the EPA's proposed standard. The city provided no information on radon levels in tap water but contends that levels at the tap will be "significantly lower" than the national standard due to radon decay (wherein radon theoretically dissipates after it is pumped up from wells and before it reaches taps). Houston apparently intends to comply with a weaker alternative standard, which allows tap water to exceed the regular standard in water systems that have programs to mitigate radon exposure from other sources—in basements, for example. Even with lower levels, EPA data indicate that radon at half its current level in Houston's water (350 pCi/L) would nonetheless pose significant cancer risks.

HOUSTON'S RIGHT-TO-KNOW REPORTS

Houston's Right-to-Know Reports Earned a Grade of Poor for 2000 and Fair for 2001

On the good-citizen side of the ledger:

▶ The reports included prominent placement of the mandatory special alert for people who are more vulnerable to contaminants like *Cryptosporidium*. Houston went beyond the required language to capitalize important words, such as *immunocrompromised persons, organ transplants,* and others.

▶ The reports included bolded language encouraging the public to copy the report and landlords to post the reports in prominent places.

▶ The report included a sentence translated into Spanish urging Spanish-speaking consumers to obtain more information in their native tongue from the city.

▶ The reports contained information on unregulated contaminants.

▶ Reports from current and past years are available on the Internet, as required.

On the could-be-a-better-citizen side of the ledger:

▸ Houston prominently and incorrectly stated on the first page of its 2000 report that "EPA is reviewing the arsenic standard recognizing that while *traces of arsenic in the diet are beneficial*, chronic exposure to concentrations *greater than* the maximum contaminant level (MCL) may cause health problems. [Emphasis added.]" In fact, both the National Academy of Sciences (NAS) and the EPA have rejected the discredited industry contention that "traces of arsenic in the diet are beneficial" to humans. In addition, both the EPA and the NAS have found that concentrations of arsenic *below* the currently enforceable MCL cause health problems—not just levels *greater than* the MCL. This misleading statement contributed to Houston's Poor grade in 2000. In 2001, Houston dropped the misleading information on arsenic and instead included EPA-required language, helping the grade improve to Fair that year.

▸ The 2000 and 2001 reports both stated, "Since 1993, we have been routinely monitoring our rivers and treated water leaving our filtration plants for [*Crypto* and *Giardia*]. To date, we have detected no confirmed occurrences of either of these in any of our drinking water." [30] However, Houston avoided informing customers of the following: that it had detected *Crypto* in its source waters, that it is difficult to detect or confirm *Crypto* in treated water, and that water filtration, while helpful in reducing *Crypto* if optimized, does not necessarily achieve complete *Crypto* control.[31]

▸ The map of water service areas was imprecise and difficult to read, making it difficult for customers to know where their water comes from and what the quality of their water is. The reports included no maps of source waters and no information on specific known or potential sources of pollution or of any specific polluters.

▸ Houston's right-to-know reports included no health risk information on contaminants found at levels above the EPA health goals. Although not legally required, such information would help local citizens to protect their health and fight for better protection of their water.

▸ The reports repeatedly implied that the water poses no health risks. For example, the phrases, "None were above the MCL" and "Presence of contaminants does not necessarily indicate that water poses a health risk" were prominently displayed in the 2000 report in at least four different places, including in the titles of the tables.

▸ The reports contained no information on how drinking water is treated.

▸ The tables are difficult to read because the typeface is extremely small.

THREATS TO HOUSTON'S SOURCE WATER

Houston Received a Source Water Protection Grade of Poor

Most of the drinking water provided to Houston residents comes from the San Jacinto and Trinity Rivers, both of which are threatened by pathogen and pesticide pollution, urban runoff, and agricultural runoff.

The EPA's Index of Watershed Indicators (IWI) has determined that a major Houston-area watershed, the Buffalo-San Jacinto Watershed, has serious contamination problems and is vulnerable to contamination. The watershed received an overall index rating of 5, on a scale of 1 to 6, where 6 is the worst possible rating. This watershed includes the San Jacinto River but not the Trinity.[32] Groundwater–source water data is not included in the EPA's IWI profile. In addition, the database is outdated. Still, it is one of the few EPA resources available to assess possible threats to its source water for drinking water.

The IWI identifies a partial source of water impairment for the years 1990 to 1999. According to IWI data, pathogens and pesticides from municipal public sewer systems and urban runoff are the most prevalent causes of pollution in area rivers, including the San Jacinto. Five to 25 percent of ambient groundwater and surface water samples have chemical levels exceeding one-half of the drinking water standard during the years 1990–1998.[33]

Second, the Buffalo-San Jacinto Watershed is highly susceptible to contamination from urban runoff (which occurs when water passes through an urban environment, picking up particles, dirt, and chemicals, and then flows into area water resources). Much of the land area has been paved and causes a lot of runoff.[34]

Drinking water sources within the watershed are also likely to be affected by agricultural runoff, which can cause microbial, nitrogen, and other nutrient problems and pesticide contamination.[35]

Houston is not the only city that uses Trinity River water for drinking water; Dallas–Forth Worth relies on the upper Trinity as well. Because so many people rely on this river, the Trinity River Authority estimates that it "is the most strategically important water body in Texas."[36] According to the IWI data, the river's watershed area receives an overall index rating of 5.[37] Pathogens and organic material probably resulting from urban runoff and municipal users have affected the water bodies surveyed within this cataloging unit.[38]

PROTECTING HOUSTON'S DRINKING WATER

The following are approaches to treating Houston's drinking water and information on how residents can help protect their local water.

Treatment Options Available for Contaminants of Greatest Concern

Before surface water enters the distribution system, Houston uses a process of sedimentation, coagulation, filtration with granular activated carbon (GAC), and disinfection, with chlorine as the primary disinfectant. Houston disinfects groundwater sources for drinking water with chlorine.[39] The city operates four treatment plants.

Houston's chlorination by-product levels could be reduced with improved treatment. For example, enhanced coagulation, more effective use of GAC, and the use of an alternative primary disinfectant such as ozone or ultraviolet light could reduce by-product levels further. Membrane treatment would remove not only the precursor compounds necessary for creating these disinfection by-products, but it also would remove virtually all other major chemical contaminants (such as arsenic) found in Houston's water. Furthermore, switching to chloramines instead of chlorine as a secondary disinfectant in the distribution system would modestly reduce chlorination by-products.

Ozone or ultraviolet light would offer a measure of additional assurance that *Crypto* poses no risk to Houston residents since these disinfection technologies are far more effective than chlorine is at killing these and certain other resistant parasites.

A number of treatment techniques are available to Houston that would substantially reduce its arsenic levels at a reasonable cost. Among the options are activated alumina and ion exchange with brine recycle. Another technology is microfiltration membranes used after chemical treatment/coagulation with ferric chloride.[40] Other newer, lower-cost technologies are also becoming available, such as "specific anion nanoengineered sorbents" or granular ferric hydroxide.[41,42]

The EPA has found that radon levels in tap water are very inexpensive to reduce using aeration, a technology that essentially bubbles air through the water. The cost per household is less than $0.80 per month for families served by a large utility the size of Houston's, according to the EPA.[43]

Houston's Capital Improvement Plans

Houston's drinking water operations had a projected $181 million budget in fiscal year 2001.[44] Houston has several water capital improvements in planning stages, including upgrading and optimizing a surface water treatment plant, replacing water wells, rehabilitating ground storage tanks, repairing water mains, corrosion prevention and rehabilitation measures, and groundwater wellhead protection. The five-year projected capital budget for drinking water is estimated by the city to be $680 million.[45]

For fiscal year 2002, Houston has a projected budget of $1 million for the implementation of water conservation measures required by regulations. However, Houston has allocated few funds to water conservation implementation measures in the future; furthermore, it appeared that no funds were allocated for FY 2003 through FY 2006.[46] Considering that groundwater sources are in decline and surface water supplies are polluted and must be treated, water conservation should be a high priority for Houston.

Water Wars: Growing Demand Will Plague Source Waters

In the past, Houston depended on groundwater for roughly 80 percent of its drinking water, but groundwater aquifers have begun to decline seriously from overuse, causing land to sink in some areas.[47] Today, 67 percent of drinking water comes from surface water sources and the rest from groundwater sources.[48] The groundwater sources are at risk of contamination and are threatened by infiltration of polluted surface water, land disposal of wastes, dumps, stockpiles, feedlots, pesticides and fertilizers, urban runoff, aboveground storage tanks, septic tanks, holding ponds, landfills, leakage from underground storage tanks, and mines.[49]

Severe cases of groundwater contamination have emerged in Harris County. Residents living in subdivisions built on top of or next to old industrial sites have complained of particle-filled and foul-tasting water, as well as illnesses that may be linked to contamination. For example, high levels of chlorides and benzene (more than 16 and 60 times allowable levels, respectively) were found in the drinking water wells of Bordeaux Estates, a neighborhood bordering a gas plant and abandoned oil wells. Residents there have reportedly developed thyroid problems and cancerous growths and have experienced extreme itchiness all over their bodies.[50]

In 2001, NRDC asked the city of Houston for information on any known sources of impairment to Houston's surface and ground source waters, but the most recent document the city supplied was more than 10 years old.[51]

The system takes drinking water from several surface water sources: the Trinity River via Lake Livingston and the San Jacinto River via Lake Houston and Lake Conroe. Water rights to these rivers are owned by the state of Texas, and the lakes used for drinking water are actually human-made reservoirs constructed to hold captured river water specifically for the purpose of human consumption. Maintenance of these lakes is apparently funded with revenue from consumer water bills. Lake Livingston is under the shared ownership of the city of Houston and the Trinity Water Authority and is "completely financed by city of Houston water bills." [52] The San Jacinto River Authority and the city own rights to Lake Conroe.

The future use of these reservoirs is part of a regional debate on how Houston will be able to meet future demands for drinking water without increasing the strain on source waters. The demand for water is expected to increase as the Houston area continues to develop. Some areas, such as the west side, where most population growth is predicted, are expected to have a "severe shortage of water" in the future.[53] Conservation, reclamation (reusing wastewater after treatment), and building new reservoirs are options under consideration.

Source Water Protection Program

Houston and the state of Texas have not yet completed their source water assessment for Houston, which must be finished by 2003. However, the Texas Natural Resources Conservation Commission (TNRCC) published its lengthy action plan in February 1999 and discussed in detail several phases in which the source water assessments will be undertaken. In the first phase, initial assessments will be completed. [54] These assessments will be updated in the second phase. The commission had planned that by 2001, 55 percent of Texas residents receiving drinking water from public systems would be served from sources protected from degradation by a source water protection program.[55] The TNRCC "outsourced" to the Texas Rural Water Association its source water protection activities and asserts that 65 percent of the public water systems in the state had source water protection strategies by 2001.[56] However, detailed data are not available to verify whether any actual on-the-ground improvement in water quality or reduced water pollution has been achieved due to this activity. At the conclusion of the assessments, the commission and the city of Houston are required to share the results with the public.

Aside from the federally mandated source water assessment, Houston has other protection measures in place, including a wellhead protection program and a water conservation plan. Of course, water conservation goes hand in hand with source water protection. The Houston city council adopted a formal water conservation plan in 1998 that reportedly touches on current and future conservation measures.[57]

HOUSTON

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Water Production Branch
City of Houston
Department of Public Works and Engineering
611 Walker Street, 21st Floor
Houston, Texas 77002
713-837-0600
www.ci.houston.tx.us/pwe/utilities/index.htm

WATER UTILITY INFORMATION

How Individuals Can Protect Source Water

Citizens can help protect the city's drinking water by working to protect its sources—both by conserving water in their daily lives and by getting involved in community decision making about water resources.

▶ **The Water Conservation branch of Houston's Public Utilities Department distributes conservation kits** to Houston residents who are concerned about saving water. Contact the Water Conservation Branch, 713-837-0473, to request a kit.

▶ **Attend meetings of your local water supplier**, the City of Houston Department of Public Works and Engineering. Check the right-to-know report or call about meeting dates, times, and locations.

▶ **Get involved in source water assessment and protection efforts** by contacting the water department or find a state government contact by calling the Safe Drinking Water Hotline at 800-426-4791.

▶ **Learn more from these groups:**

- Clean Water Action in Houston, Texas, www.cleanwateraction.org/tx/index.htm, 713-529-9426, txcwa@cleanwater.org
- Clean Water Network, www.cwn.org, cleanwater@igc.org

Peer reviewers for the Houston report included Sparky Anderson, Texas Clean Water Action.

NOTES

1 Safe Drinking Water Information System (SDWIS). U.S. Environmental Protection Agency database. Available online at: http://oaspub.epa.gov/enviro/sdw_report.first_table?report_id=620605&pwsid=TX1010013&state=TX&source=Surface%20water%20&population=2354040&sys_num=0. Last visited April 23, 2002.

2 Ibid.

3 "Larger Cities Report Capital Improvement Needs," *WaterWorld*, December 2001, available online at www.pennet.com.

4 See note 1.

5 Ibid.

6 See, EPA, Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) Preproposal Draft Regulatory Language for Stakeholder Review, posted at www.epa.gov/safewater/mdbp/st2dis.html. The 1, 2, and 2.5 minimum log removal requirements are converted into percentage removals for simplicity. This rule has not been formally proposed in *The Federal Register*, but was agreed to by the EPA, NRDC, public health groups, cities, and the water utility industry. See *Ibid* for the "FACA Stakeholder Agreement in Principle."

7 Houston ICR Monitoring Data, as reported in EPA Information Collection Rule Database, www.epa.gov/enviro/html/icr/utility/report/TX1010013960929085044.html.

8 City of Houston Department of Public Works and Engineering, "Water Quality Report 2001," available online at www.ci.houston.tx.us/pwe/utilities/01report.pdf; City of Houston Department of Public Works and Engineering. Also "Water Quality Report 2000," available online at www.ci.houston.tx.us/pwe/utilities/00report.pdf.

9 Note that the contaminant levels are presented as a percentage. Total coliform is regulated as a percentage of positive samples that are present in water. The national health standard of 5 percent means that if more than 5 percent of the utility's total coliform samples test positive, then the national health standard has been violated. To say that a sample tests positive is to say that there are total coliform bacteria present in the sample. Therefore, for compliance purposes, the utilities provide the percentage of total coliform samples that tested positive.

10 City of Houston Department of Public Works and Engineering, "Water Quality Report 1999," available online at www.ci.houston.tx.us/pwe/utilities/99report.pdf.

11 City of Houston Department of Public Works and Engineering, "Water Quality Report 2000," available online at www.ci.houston.tx.us/pwe/utilities/00report.pdf .

12 City of Houston Department of Public Works and Engineering, "Water Quality Report 2001," available online at www.ci.houston.tx.us/pwe/utilities/01report.pdf.

13 See note 5.

14 See note 6.

15 See note 7.

16 Feldstein, Daniel and Bill Prewitt. "The Water Puzzle: Arsenic and Old Standards: What's Livable?" *The Houston Chronicle*, November 5, 2000, Section A, p. 1.

17 The action level standard for lead is different from the standard for most other contaminants. Water utilities are required to take many samples of lead in the tap water at homes they serve, including some "high-risk" homes judged likely to have lead in their plumbing or fixtures. If the amount of lead detected in the samples is more than 15 ppb at the 90th percentile (which means that 90 percent of the samples have 15 ppb or less), then the amount is said to exceed the action level. Under the complex EPA lead rule, a water system that exceeds the action level is not necessarily in violation. If a system exceeds the action level, additional measures such as chemical treatment to reduce the water's corrosivity (ability to corrode pipes and thus its ability to leach lead from pipes) must be taken. If this chemical treatment does not work, the water system may have to replace lead portions of its distribution system if they are still contributing to the lead problem.

18 See note 6.

19 Some of the haloacetic acids have national health goals of 0 and others have nonzero goals. For the sake of simplicity and understandability, since there is a single haloacetic acid standard, and because it is essentially chemically impossible under normal conditions in tap water to create one regulated haloacetic acid without creating the others at some level, we have listed the national health goal as 0.

20 City of Houston Department of Public Works and Engineering, "Water Quality Report 2000," available online at www.ci.houston.tx.us/pwe/utilities/00report.pdf. Note that the levels are for year 1998.

21 See note 8.

22 Total trihalomethanes (TTHMs) consist of a sum of the levels of four closely related chemicals—chloroform, dibromochloromethane, bromoform, and bromodichloromethane—which occur together at varying ratios when water is chlorinated. The latter two TTHMs have health goals of 0. The EPA promulgated and then withdrew (after a court decision) a 0 health goal for chloroform and has not yet issued a new goal for chloroform. Dibromochloromethane has a health goal of 60 ppb. Since water systems generally report only the combined TTHM level, and since it is essentially chemically impossible to create one trihalomethane in tap water without some level of the others, we list the health goal for TTHMs as 0.

23 See note 8.

24 Ibid.

25 See note 6.

26 Ibid.

27 See note 7.

28 See note 6.

29 Ibid.

30 City of Houston Department of Public Works and Engineering, "Water Quality Report 2001," available online at www.ci.houston.tx.us/pwe/utilities/01report.pdf. City of Houston Department of Public Works and Engineering, "Water Quality Report 2000," available online at www.ci.houston.tx.us/pwe/utilities/00report.pdf.

31 See note 7.

32 Index of Watershed Indicators, U.S. EPA database, available online at www.epa.gov/iwi/hucs/12040104/score.html, last visited April 23, 2002.

33 Ibid.

34 Ibid.

35 Ibid.

36 Trinity River Authority, available online at www.trinityra.org/abouttour1.htm, last visited April 22, 2002.

37 Index of Watershed Indicators, U.S. EPA database, available online at www.epa.gov/iwi/hucs/12030105/score.html, last visited April 22, 2002.

38 Ibid.

39 Personal communication with Connie Henriques, with the City of Houston Department of Public Works and Engineering, April 17, 2002.

40 EPA, "Arsenic in Drinking Water Treatment Technologies: Removal," available online at epa.gov/safewater/ars/treat.html. Report of Arsenic Cost Working Group of the National Drinking Water Advisory Council, August 14, 2001, available online at www.epa.gov/safewater/ars/ndwac-arsenic-report.pdf. City of Albuquerque, "Arsenic Removal," available online at www.cabq.gov/waterresources/arsenicremoval.html.

41 S.J. Ludescher, "Sandia Process Traps Arsenic Cheaply," *Albuquerque Tribune*, p. A1, May 29, 2001; Sandia National Laboratories, "Sandia Arsenic Catchers Could Help Communities Supply Safer Drinking Water Affordably," News Release, May 24, 2001, available online at www.sandia.gov/media/NewsRel/NR2001/sanssorb.htm.

42 See, *e.g.*, Report of Arsenic Cost Working Group of the National Drinking Water Advisory Council, August 14, 2001, available online at www.epa.gov/safewater/ars/ndwac-arsenic-report.pdf.

43 EPA, Proposed Radon in Drinking Water Rule, 64 Fed. Reg. 59246, 59328 (Table XIII.11) (November 2, 1999).

44 City of Houston, PWE, Water Production Branch, www.ci.houston.tx.us/pwe/utilities/index.htm, last visited April 23, 2002.

45 "Larger Cities Report Capital Improvement Needs," *WaterWorld,* December 2001, available online at www.pennet.com.

46 Water Capital Improvement Program, proposed FY '02–'06 CIP, revised August 31, 2001, City of Houston.

47 Feldstein, Dan, "The Water Puzzle: Region Faces Challenge of Meeting Demand." *The Houston Chronicle,* August 13, 2000, Section A, p. 1.

48 See note 6.

49 Cross, Brad L., Terry, David P., and Billings, Valerie R., "A Public Water Supply Protection Strategy," July 1991, City of Houston, Table 1: Sources of Water Quality Degradation, pp. 3+.

50 Tingle, Teresa, "Subdivisions Complain of Wells' Troubled Water; Residents Say Contamination Makes Them Sick," *The Houston Chronicle*, March 17, 2002, Section A, p. 37.

51 Cross, Brad L., Terry, David P., and Billings, Valerie R., "A Public Water Supply Protection Strategy," July 1991, City of Houston.

52 Feldstein, Dan, "The Water Puzzle; Regional Water Plan Draws Criticism; Environmentalists, Lake Residents Voice Fears over Reservoir Levels," *The Houston Chronicle*, September 22, 2000, Section A, p. 29.

53 "Our Water Resources," *The Houston Chronicle*. August 15, 2000, available online at www.chron.com/cs/CDA/story.hts/graphics/634231, last visited April 22, 2002.

54 Source Water Assessment and Protection Program Strategy, prepared by Source Water Assessment and Protection Team, Public Drinking Water Section, Water Utilities Division, February 1999.

55 Ibid.

56 See Texas Natural Resources Conservation Commission, "Source Water Protection Outsource Initiative," available online at www.tnrcc.state.tx.us/permitting/waterperm/pdw/swap/swpcon.html

57 Little information was available on the conservation plan via Houston's website, nor did Houston provide NRDC with a copy of the plan in response to a written request for drinking water information.

58 See note 6.