Drinking water in Michigan: source, quality, and contaminants

Vincent R. Nathan

ABSTRACT

The Michigan Safe Drinking Water Act (Act 399) was enacted in 1976 and enables the Michigan Department of Environmental Quality (DEQ) to maintain the state's authority over drinking water in the state. The DEQ also contracts with local health departments to maintain non-community programs in each county. Private water wells throughout the state are clearly the most troublesome for users and regulators. An abundant array of contaminants (e.g., pesticides, metals, etc.) may impact wells without the user's knowledge. Most private wells are only inspected when they are installed and have no further regulatory requirements. With regards to contaminants in public systems, lead is problematic. Irregardless of the source or treatment, the piping infrastructure leading to and inside the home can be a source affecting the quality. Thus, the problem of lead in drinking water can be from the service lines, the pipes inside the home, the solder connecting the pipes, or in some case the treatment chemicals used for disinfection.

Key words | Drinking water, water wells, public health, public information, lead

Vincent R. Nathan
Department of Health & Wellness Promotion,
1151 Taylor Street, Detroit,
Michigan 48202,
USA
Tel: 313-876-4910
Fax: 313-876-0088
E-mail: *nathanv@health.ci.detroit.mi.us*

INTRODUCTION

Nationally, a significant portion of public water supply withdrawals occur in the Great Lakes Basin, which ranks fourth among the 21 major watersheds in the Nation. As a state, Michigan has the eighth largest public water supply withdrawals, following California, Texas, New York, Florida, Illinois, Pennsylvania, and Ohio. Within the United States portion of the Great Lakes Basin, Michigan accounts for the largest amount of water withdrawn for public water supply systems. While the total volume of this water is significant, the amount lost to the region due to evaporation, transpiration, and incorporation into products is estimated to be between 10 and 15%.

Data have also been compiled for Michigan's community public water supply systems. They are defined as systems that provide year-round water service to at least 15 service connections or serve an average of at least 25 residents. Community public water suppliers are required to employ certified operators and are monitored periodically to ensure that they meet all applicable state and federal standards. Michigan's 1,500 community public water supply systems withdrew 1,191 million gallons of water per day (MGD) during 2001. This represents a total water volume of nearly 435 billion gallons for the year, delivered to residential, commercial, industrial, and public facilities serving 6.9 million persons. Over 77% of the water withdrawn for community public water supply systems came from the Great Lakes and their connecting waters, with about 21% of water withdrawals from ground water. Less than 2% of withdrawals were from inland lakes and streams, which are generally not used for community public water supply in the state.

Private water wells are clearly the most troublesome for users and regulators. Most private wells are only inspected when they are installed and have no further regulatory requirements. Owners and /or users of private wells may petition a local health department or private laboratory to test the well, whether or not contamination is suspected. Unlike public drinking water systems serving many people,

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they do not have regular checks on the water's source and its quality before it is sent to the tap. These households must take special precautions to ensure the protection and maintenance of their drinking water supplies.

With regards to contaminants, and especially lead, even public systems have problems. Irregardless of the source or treatment, the piping infrastructure leading to and inside the home can be a source affecting the quality. The problem of lead in drinking water can be from the service lines, the pipes inside the home, the solder connecting the pipes, or in some case the treatment chemicals used for disinfection.

BACKGROUND

The Michigan Department of Environmental Quality (DEQ) has primary enforcement authority in Michigan for the Federal Safe Drinking Water Act under the legislative authority of the Michigan Safe Drinking Water Act. As such, the division has regulatory oversight for all public water supplies, including approximately 1,500 community water supplies and 11,000 non-community water supplies. In addition, the program regulates drinking water well drilling. About half the population of Michigan depends on groundwater as the primary source of drinking water. Many of these individuals, especially those residing in rural areas, have their own wells. Michigan has more households (1.12 million) served by private wells than any other state, with approximately 25,000 domestic wells drilled per year. The DEQ also investigates drinking water well contamination, and oversees remedial activities at sites of groundwater contamination affecting drinking water wells.

Unplugged abandoned wells can threaten the quality of drinking water from both private wells and those servicing public water supply systems. It is estimated that over 2 million unplugged wells exist in Michigan. Community Water Supply oversees the primary EPA program which sets forth minimum standards for safe drinking water as well as administering the requirements of Michigan's Safe Drinking Water Act. This program includes approximately 1,500 communities water supply. The program's primary function is regulatory oversight of community public water supplies.

The Michigan Safe Drinking Water Act (Act 399) was enacted in 1976 and enables the Michigan Department of Environmental Quality (DEQ) to maintain the state's authority over the drinking water program. The DEQ also contracts with local health departments to maintain non-community programs in each county. A non-community water supply is a water system which provides water for drinking or household purposes to 25 or more persons at least 60 days per year or has 15 or more service connections. Schools, restaurants, motels, campgrounds, and churches with their own well are typical non-community water systems.

In Michigan, DEQ assists local health departments in conducting drinking water quality investigations in areas of known or suspected environmental contamination. They provide assistance by advising local health department staff, and others conducting groundwater quality investigations, in the selection of drinking water locations sampled, types of analyses needed to be performed, and scheduling of the Department of Environmental Quality Water Lab analysis.

The Detroit Water and Sewerage Department (DWSD) provides drinking water to approximately 4.3 million people in 126 southeast Michigan communities. The system uses water drawn from three intakes. Two intakes are located in the Detroit River; the third intake is located in Lake Huron. The Department has five water treatment plants. Four of the plants treat water drawn from the Detroit River intakes. The fifth water treatment plant is located in St. Clair County and uses water drawn from Lake Huron. City of Detroit customers are provided service from four plants which treat water drawn from the Detroit River. Innovative ozonation techniques provides a very high quality water distributed through the local system. The table below (Detroit Water and Sewerage Department 2003) shows 2003 water quality laboratory analyses reports from the City of Detroit.

The Michigan Department of Environmental Quality (MDEQ) is completing a Source Water Assessment Program (SWAP) as required by the 1996 reauthorization of the federal Safe Drinking Water Act (SDWA). This program assists local communities utilizing groundwater for their municipal drinking water supply systems in protecting their water source. A SWAP minimizes the potential for contamination by identifying and protecting the area which contributes water to municipal water supply wells and avoids costly groundwater clean-ups.

HEALTH EFFECTS OF LEAD

High levels of lead in tap water can cause health effects if the lead in the water enters the bloodstream and causes an elevated blood lead level. Most studies show that exposure to lead-contaminated water *alone* would not be likely to elevate blood lead levels in most adults, even at exposure to water with a lead content close to the Environmental Protection Agency's (EPA's) "action level" for lead of 15 parts per billion (ppb). Risk will vary, however, depending upon the individual, the circumstances, and the amount of water consumed. For example, infants who drink formula prepared with lead-contaminated water may be at a higher risk because of the large volume of water they consume relative to their body mass.

Clearly, measures taken during the last two decades have greatly reduced exposures to lead in the environment and in tap water. These measures include actions taken under the requirements of the 1986 and 1996 amendments to the Safe Drinking Water Act and the EPA's Lead and Copper Rule. Nevertheless, lead still can be found in some metal water taps, interior water pipes, or pipes connecting a house to the main water pipe in the street. Lead found in tap water usually comes from the corrosion of older fixtures or from the solder which connects pipes. When water sits in leaded pipes for several hours, lead can leach into the water supply.

Additionally, cities across the country are said to be manipulating the results of tests used to detect lead in water, violating federal law and putting millions of Americans at risk. According to the Washington Post (Leonnig *et al.* 2004), some cities, including Philadelphia and Boston, have thrown out tests which show high readings or have avoided testing homes most likely to have lead, records show. In New York City, the nation's largest water provider has for the past three years assured its 9.3 million customers that its water was safe because the lead content fell below federal limits. But the city has withheld from regulators hundreds of test results which would have raised lead levels above the safety standard in two of those years, according to records. The Lansing (MI) State Journal (Lambert 2004) reports that many smaller cities and suburban communities are unsure of the extent of lead pipes affecting their drinking water.

CONCLUSIONS

Since 1992, with the cooperation of many Detroit residents, DWSD has been testing homes with plumbing systems which may contribute lead to the household water supply. These survey results have reported lead levels to be low. However, infants and children who drink water containing lead in excess of the action level could experience delays in their physical or mental development. Children could show slight deficits in attention span and learning disabilities. Adults who drink this water over many years could develop kidney problems or high blood pressure.

Drinking water is rarely the sole cause of lead poisoning in adults or children. Nevertheless, EPA has estimated that between 10% and 20% of human exposure to lead can come from drinking water. Furthermore, infants drinking formula mixed with lead-containing water can receive between 40% and 60% of their lead exposure. Still it is unclear if these exposures correlate with elevated blood-lead levels. While the municipal drinking water from a plant may be lead-free, lead service lines, lead solder used on copper pipes, and faucets made of brass are all common sources. Old housing stock and poor municipal infrastructure data, together pose the greatest uncertainties.

Further complicating the issue is the reporting. In Michigan, on August 8, 2004, the Lansing State Journal (Lambert 2004) reported that at least five cities outside the City of Lansing have lead service lines transporting water

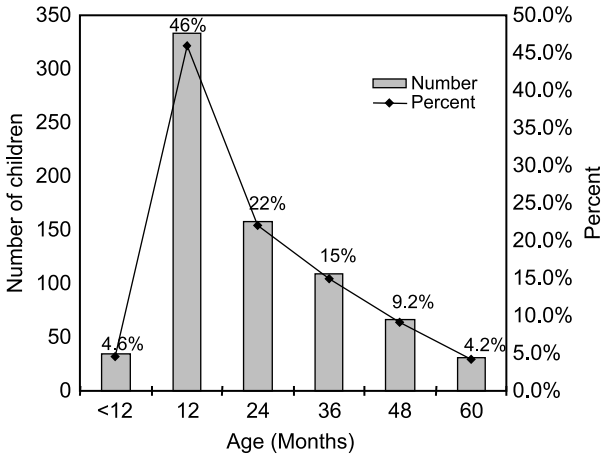

Figure 1 | Incidence of Lead Poisoning Citywide 2004.

Table 1 | City of Detroit Public Water System 2003 Regulated Detected Contaminants

Contaminant	Test date	Units	Health goal MCLG	Allowed level MCL	Highest level detected	Range of detection	Violation Yes/No	Major sources in drinking water
Inorganic Chemicals – Annual Monitoring at Plant Finished Water Tap								
Flouride	9/102003	ppm	4	4	12	1.1–1.2	No	Erosion of natural deposits; Water additive which promotes strong teeth; Discharge from fertilizer and aluminum factories
Nitrate	9/102003	ppm	10	10	0.40	0.40	No	Runoff from fertilizer use; Leaching from septic tanks, sewage; Erosion of natural deposits
Disinfectant Residuals and Disinfections By-Products – Monitoring in Distribution System (level detected is the highest running annual average based on quarterly averages)								
Total Trihalomethanes (TTHM)	Feb-Dec 2003	ppb	n/a	80	17.1	0.0–27.3	No	By-product of drinking water chlorination
Haloacetic Acids (HAAS)	Feb-Dec 2003	ppb	n/a	60	12.4	0.0–25.0	No	By-product of drinking water disinfection
Disinfectant (optional) Residual (ppm)	Jan-Dec 2003	ppb	MRDGL 4	MRDL 4	0.75	0.54–0.82	No	Water additive used to control microbes

2003 Turbidity – Monitored every 4 hours at Plant Finished Water Tap

Highest Single Measurement Cannot exceed 1 NTU	Lowest Monthly % of Samples Meeting Turbidity Limit of 0.3 NTU (minimum 95%)	Violation Yes/No	Major Sources in Drinking Water
0.29	100%	No	Soil Runoff

Turbidity is a measure of the cloudiness of water. We monitor it because it is a good indicator of the effectiveness of our filtration system

2003 Microbiological Contaminants – Monthly Monitoring in Distribution System

Contaminant	MCLG	MCL	Highest Number Detected	Violation Yes/No	Major Sources in Drinking Water
Total Coliform Bacteria	0	Presence of Coliform bacteria 5% of monthly samples	In one month 3.22%	No	Naturally present in the environment

Table 1 | (*continued*)

Contaminant	Test date	Units	Health goal MCLG	Allowed level MCL	Highest level detected	Range of detection	Violation Yes/No	Major sources in drinking water
E. coli or fecal coliform bacteria	0		A routine sample and a repeat sample are total Coliform positive and one is also Fecal or *E. coli* positive.		Entire year 0		No	Human waste and animal fecal waste

Lead and Copper Monitoring at Customers' Tap

Contaminant	Test Date	Units	Health MCLG Goal	Action Level AL	90th Percentile Value *	Number of Samples Over AL	Violation Yes/No	Major Sources in Drinking Water
Lead	2002	ppb	0	15	11.6	2	No	Corrosion of household plumbing system; Erosion of natural deposits; Leaching from wood preservatives.
Copper	2002	ppb	1300	1300	148.5	0	No	

*The 90th percentile value means 90 percent of the homes tested have lead and copper levels below the given 90th percentile value. If the 90th percentile value is above the AL additional requirements must be met.

Regulated Contaminant	Treatment Technique	Running Annual Average	Monthly Ratio Range	Violation Yes/No	Typical source Contaminant
Total Organic Carbon (ppm)	The Total Organic Carbon (TOC) removal ratio is calculated as the ratio between the actual TOC removal and the TOC removal requirements. The TOC was measured each month and because the level was low, there is no requirement for TOC removal.			No	Erosion of natural deposits

2003 Special Monitoring

Contaminant	MCLG	MCL	Level Detected	Source of Contamination
Sodium (ppm)	n/a	n/a	Not detected	Erosion of natural deposits

Unregulated contaminants are those for which EPA has not established drinking water standards. Monitoring helps EPA to determine where certain contaminants occur and whether it needs to regulate those contaminants. Note: Though these data are important, testing at the tap is the only way of knowing the quality of individual water supplies, especially for lead.

to homes but the extent is not known because of poor or no record-keeping. The Tuesday, October 5, 2004, Washington Post newspaper (Leonnig *et al*, 2004) reported that cities across the country are manipulating the results of tests used to detect lead in water, violating federal law and putting millions of Americans at risk of drinking more of the contaminant than their suppliers are reporting. Some cities have thrown out tests which show high readings or have avoided testing homes most likely to have lead. The result is that communities large and small may have a false sense of security about the quality of their water and that utilities can avoid spending money to correct the problem.

The reported records point to a national problem just months after disclosures that lead levels in the District of Columbia's water are among the highest in the country, a problem the city's utility concealed for months. Documents from other cities show that many have made similar efforts to hide high lead readings, taking advantage of lax national and state oversight and regulations riddled with loopholes. The Washington Post (Leonnig *et al*. 2004) examined 65 large water systems whose reported lead levels have hovered near or exceeded federal standards. Federal, state and utility records show that dozens of utilities obscured the extent of lead contamination, ignored requirements to correct problems and failed to turn over data to regulators.

Given the absence of clear data on lead in drinking water in some communities, it is difficult for high risk groups to plan contingencies. For instance, pregnant and nursing women, and those using formula, for whom information regarding lead in their drinking water is very important. Given that lead in drinking water may only be between 10% and 20% source of lead exposure, there are other issues. For example, lead cannot be removed by boiling the water. In fact hot water may increase the leaching of lead in pipes. sting at the tap is the only way of knowing the quality of indiviual burden from anThere is little doubt about the effects of lead in children and any additional body burden from any source is problematic.

In summary, the water quality in Michigan is good. The Great Lakes water quality for drinking is among the best in the nation. However, the age of the housing stock (Houston 2004) and older public infrastructures in many cities leave the prospect of lead in drinking water high.

RECOMMENDATIONS

I am recommending a nationwide survey of tapwater at homes, schools and daycare centers to determine if lead in drinking water is an exposure threat to children. Though it is debatable that lead in drinking water is a primary source of lead contamination in children, I do suggest that it is an unknown source. Figure 1 below, from the Department of Health & Wellness Promotion lead database, shows the number and percent of children in Detroit with elevated levels of blood lead. The primary sources are thought to be dust and paint, however, it is unclear how much drinking water contributes to the adverse effects.

If your home has a lead service line or piping that has lead soldered joints, you can take precautions. First, check with your water provider to ascertain if you are connected to a lead service line. Also, you may request a lead test, if the provider does not know. However, to minimize your exposure to lead that may have leached into your drinking water from your pipes:

- Run your water for 30 to 60 seconds or until it feels colder any time your water has not been used for more than 6 hours.
- Always use cold water for drinking, cooking, or making baby formula.
- Use faucets and plumbing material which are either lead free or will not leach unsafe levels of lead into your water.

The EPA (EPA http://www.epa.gov/dclead/oversight.htm) action level for lead in drinking water of 15 ppb is not a health-based recommendation. According to EPA, "This action level was not designed to measure health risks from water represented by individual samples. Rather, it is a statistical trigger that, if exceeded, requires more treatment, public education and possibly lead service line replacement." (see http://www.epa.gov/dclead/oversight.htm) Table 1.

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