



## ASSESSMENT OF TOTAL CHROMIUM IN ILLINOIS COMMUNITY WATER SUPPLIES

### Introduction

United States Environmental Protection Agency (U.S. EPA) regularly reevaluates drinking water standards and, based on new science, the agency launched a rigorous and comprehensive review of chromium-6 health effects following the release of the toxicity studies by the National Toxicology Program in 2008. In September 2010, U.S. EPA released a draft of that scientific review for public comment. When this scientific review is finalized in 2011, U.S. EPA will carefully review the conclusions and consider all relevant information to determine if a new standard needs to be proposed.

According to U.S. EPA's Web site (<http://water.epa.gov/drink/info/chromium/index.cfm>):

Chromium is a metallic element in the periodic table. It is odorless and tasteless. Chromium is found naturally in rocks, plants, soil and volcanic dust, humans and animals. The most common forms of chromium in the environment are trivalent (chromium-3), hexavalent (chromium-6) and the metal form, chromium-0. Chromium-3 occurs naturally in many vegetables, fruits, meats, grains and yeast. Chromium-6 and -0 are generally produced by industrial processes. Major sources of chromium-6 in drinking water are discharges from steel and pulp mills, and erosion of natural deposits of chromium-3. At many locations, chromium compounds have been released to the environment via leakage, poor storage, or improper disposal practices. Chromium compounds are very persistent in water as sediments.

U.S. EPA has regulated chromium-6 as part of the "total chromium" drinking water standard under the federal Safe Drinking Water Act (SDWA) since 1992. This standard addresses all forms of chromium, including chromium-6. The current drinking water standard sets the maximum contaminant level (MCL) of total chromium allowed in drinking water at 100 micrograms per liter (ug/L), or parts per billion.

Federal regulations include not only standards or MCLs, but also the approved monitoring points and analytical methods that must be used when analyzing water samples to meet federal monitoring requirements and demonstrate compliance. U.S. EPA reviews and approves methods that can be used, and certifies the laboratories that analyze these compliance samples.

U.S. EPA establishes approved analytical method detection limits (MDLs). A MDL is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the true value is greater than zero. The currently approved U.S. EPA drinking water analytical methods for total chromium are Methods 200.7, 200.8, or 200.9, which have MDLs that range from 1 ug/L to 7 ug/L for finished drinking water and ambient groundwater samples. The MDL for ambient surface water samples is 0.24 ug/L.

The Illinois EPA has been designated as the lead state agency for primary enforcement authority and oversight for the community water supplies (CWS) in Illinois. The Illinois Pollution Control Board, pursuant to Sections 7.2 and 17.5 of the Illinois Environmental Protection Act, is required to adopt the drinking water standards, compliance monitoring points, and approved analytical method detection limits promulgated by the U.S. EPA.

The State of California has recently proposed a revised draft health-based goal of 0.02 ug/L for chromium-6. Once this goal is finalized it will still need to be sent to the California Department of Public Health to set a drinking water standard that takes into account treatment technology and analytical detection capability.

<p>The Agency for Toxic Substances and Disease Registry has a non-enforceable children's drinking water health guideline of 10 ug/L and an adult water health guideline of 40 ug/L for chromium-6.</p>
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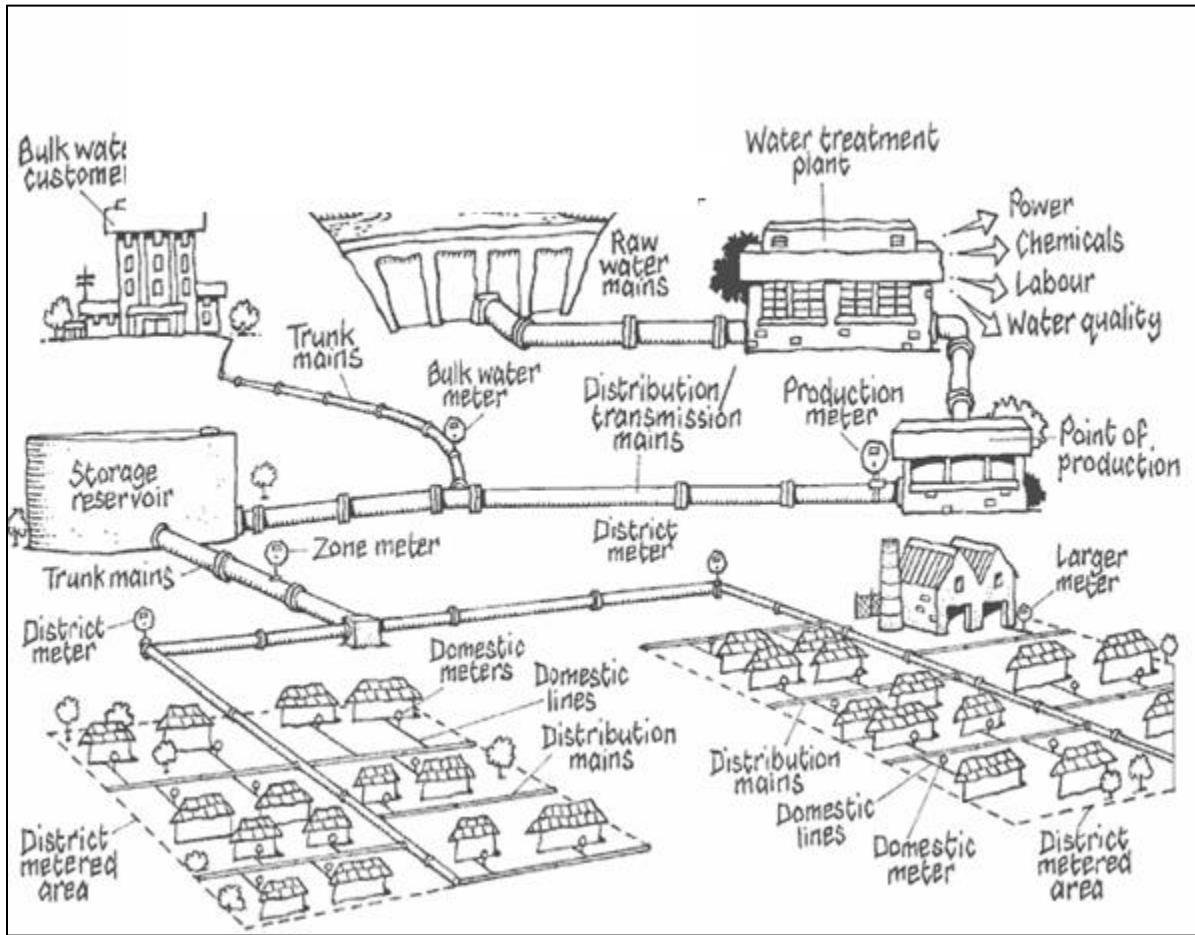
This assessment of total chromium in CWS in Illinois is organized into four sections:

- 1) summary;
- 2) drinking water quality for total chromium from CWS;
- 3) source water quality for total chromium from ambient surface water for Lake Michigan and all other CWS lakes, as well as groundwater quality from a network comprised of CWS wells; and
- 4) results and conclusions.

## Summary

A CWS is defined as a supply that serves 15 or more service connections or 25 or more residents year round. Currently (2011) there are 1,750 active CWS in the state, serving a total of 11,783,074 Illinois residents. These CWS obtain unfinished water from either surface water or groundwater sources.

The drinking water monitoring and MCLs for total chromium apply to the finished water at the entry point to the distribution system (after the water treatment plant in Figure 1). A CWS distribution system does not include domestic/service lines connecting a private residence or business to distribution system water mains, nor does it include the plumbing in a private residence or business.



**Figure 1. Public community water supply illustration**

There are no CWS in Illinois that violate the current MCL or drinking water standard of 100 ug/L for total chromium, which includes chromium-6. Moreover, the Agency for Toxic Substances and Disease Registry (ATSDR) has a non-enforceable children’s drinking water health guideline of 10 ug/L and an adult water health guideline of 40 ug/L for chromium-6. Based on the ATSDR health guideline, the Illinois EPA would not consider the levels found in finished drinking water, ambient surface water sources, or ambient groundwater sources used by Illinois CWS to pose a public health hazard.

Since 1993, total chromium has been detected in four percent of the finished drinking water samples from CWS in Illinois. Conversely, total chromium has not been detected in 96 percent of samples from CWS in Illinois. Where detected, the median concentration of total chromium in finished water is 11 ug/L.

There were 280 samples of total chromium collected from finished water for the 15 CWS using Lake Michigan. These samples showed three detections, none of which were confirmed by subsequent sampling. Therefore, the detection rate for total chromium in finished drinking water at CWS obtaining their water from Lake Michigan is zero percent.

The median concentration of total chromium in unfinished water samples taken from Lake Michigan prior to treatment is 0.51 ug/L. The median concentration of total chromium in unfinished water samples from CWS lakes (other than Lake Michigan) is 0.97 ug/L, and the median concentration of total chromium in unfinished water samples taken from groundwater sources used by CWS is 8 ug/L.

### Drinking Water Quality from CWS

Inorganic compound (IOC) data, which includes total chromium, are collected from all Illinois' CWS within a three-year cycle, i.e., it takes three years to receive finished water data from all CWS. Finished drinking water compliance data from monitoring conducted during 1993 to 2010 (six cycles) show an average of 29 out of 1,010 active groundwater CWS, per three-year cycle, have one or more total chromium detects. This represents a detection rate of three percent. During that same timeframe, an average of 12 out of 96 active surface water CWS, per three-year cycle, have one or more total chromium detects. This represents a detection rate of 13 percent. Figure 2 illustrates finished water total chromium detections from CWS in the state.

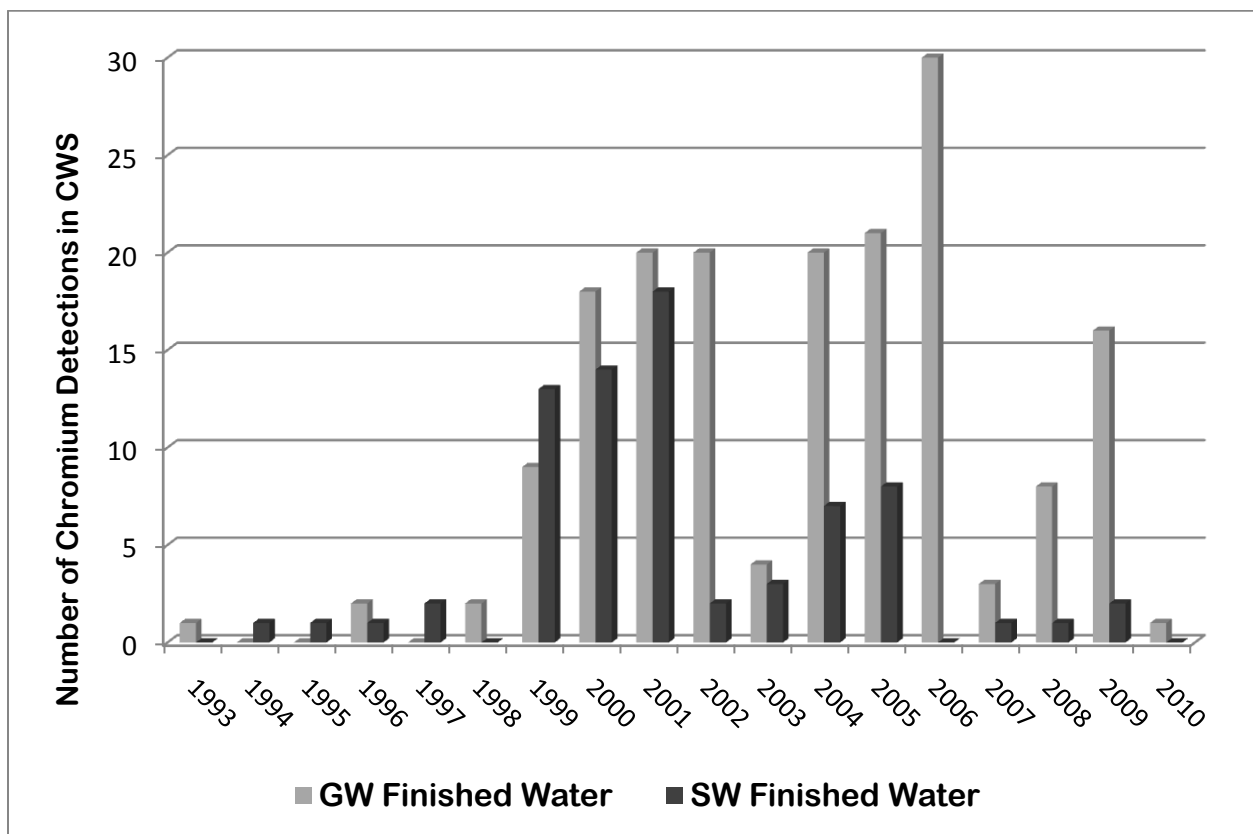
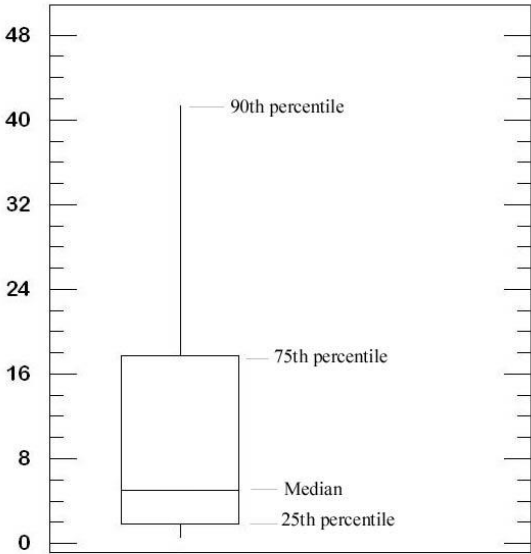


Figure 2. Total chromium detections in CWS finished drinking water samples taken at entry point to the distribution system

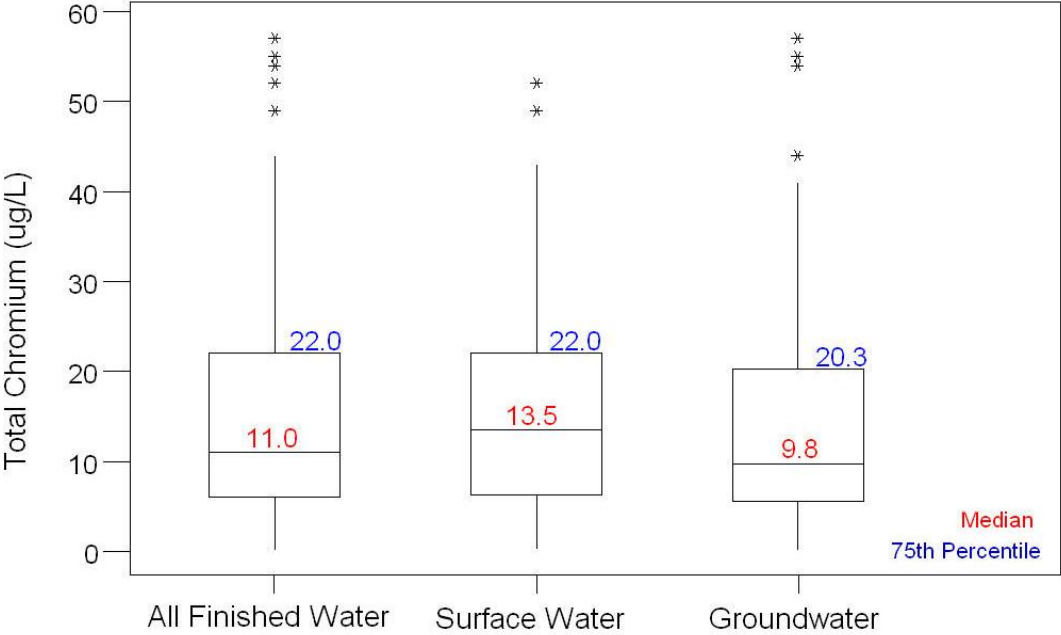
As illustrated in Figure 3, a box plot provides a statistical prediction of the concentration of a substance bounded by percentiles. In other words, the box plot shows the number of samples that have concentrations that occur below a certain value 90, 75, and 25 percent of the time.

**Figure-3. A sample box plot**



The finished water detections illustrated in Figure 2 were further analyzed to determine what concentrations of total chromium have been found. Illinois EPA used box plots to represent the finished water results. The box plots shown in Figure 4 show the baseline statistics for concentrations of total chromium when detected in finished water from the CWS in Illinois.

**Figure 4. Concentration statistics of total chromium detections from CWS finished water**



The median concentration of total chromium in all finished drinking water in Illinois is 11 ug/L and the 75<sup>th</sup> percentile value is 22 ug/L. The median concentration of total chromium in finished water from surface water supplies is 13.5 ug/L and the 75<sup>th</sup> percentile value is 22 ug/L. The median concentration of total chromium in finished water from groundwater supplies is 9.8 ug/L and the 75<sup>th</sup> percentile value is 20.3 ug/L.

## Source Water Monitoring

### Ambient Surface Water Monitoring in Lake Michigan

The Illinois EPA has collected 50 IOC samples near the CWS intakes on Lake Michigan to assess the source water quality conditions. The median source water concentration of total chromium from these samples is 0.5 ug/L and the 75<sup>th</sup> percentile value is 0.8 ug/L, as shown in Figure 5. The highest concentration of total chromium found was 1.4 ug/L.

### CWS Probabilistic Monitoring Network Results

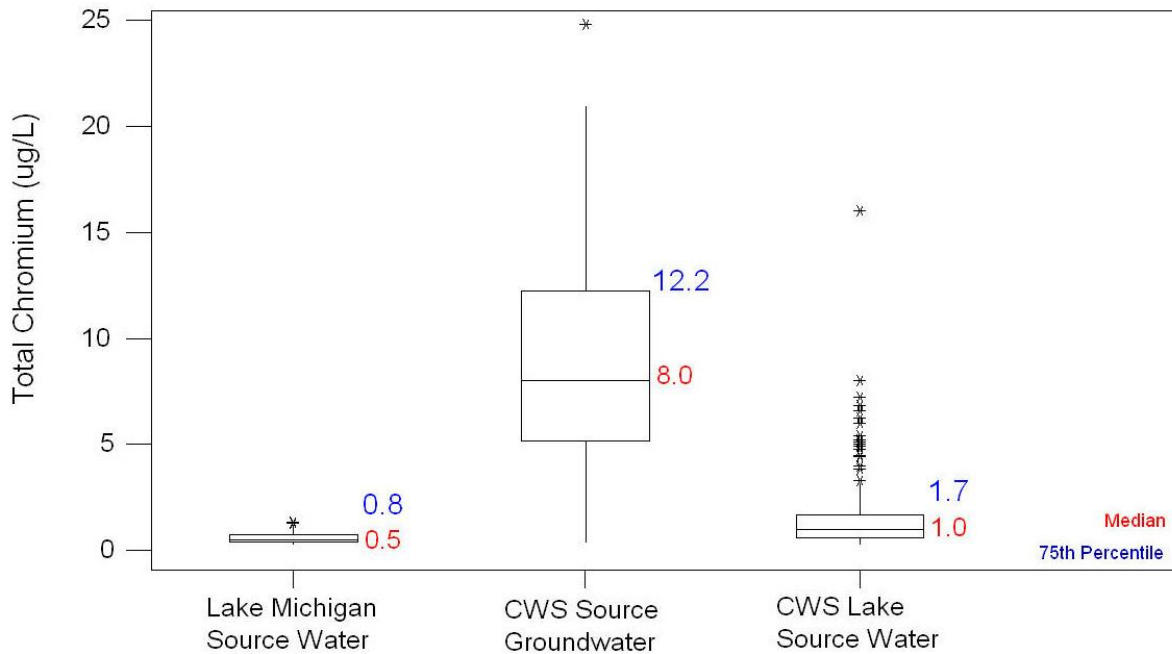
The Illinois EPA maintains a probabilistic monitoring network composed of CWS wells. The 351 active wells in the CWS probabilistic network have a long history of IOC monitoring results that can be used to assess the source water quality conditions. Out of the network's 351 wells, the median value for total chromium is 8 ug/L with a 75<sup>th</sup> percentile value of 12.2 ug/L, as shown in Figure 5. Based on the current federal drinking water standard, the numerical Class I groundwater standard for total chromium is 100 ug/L (except due to natural causes), and it includes chromium-6. However, because the historical data set for the network may include measurement results that are due to unnatural sources, additional regional and/or site specific evaluation may be needed to determine if measurements are occurring due to natural versus unnatural sources.

For more information on the CWS probabilistic network refer to the Illinois EPA's Groundwater Section of the "Water Resource Assessments" Web page at: <http://www.epa.state.il.us/water/water-quality/index.html>.

### Ambient Surface Water Monitoring at CWS Lakes

In addition to Lake Michigan, there are 81 other surface water systems that use lakes as their source of drinking water. Illinois EPA collects ambient surface water samples adjacent to the intakes on these lakes. For the 81 CWS that use lakes as sources of drinking water, there were 39 confirmed total chromium detections out of 1,255 samples. Thus, there were detections of total chromium in three percent of the samples. The median source water concentration of total chromium in these detections is 1 ug/L and the 75<sup>th</sup> percentile value is 1.7 ug/L, as shown in Figure 5.

**Figure 5. Statistical summary of total chromium concentrations from Lake Michigan, CWS Probabilistic Monitoring Network, and CWS Lakes**



## Results and Conclusions

### Finished Drinking Water

- No CWS in Illinois violate the current U.S. EPA MCL or drinking water standard for total chromium of 100 ug/L.
- There is no individual federal drinking water standard for chromium-6, which is part of the total chromium standard.
- The ATSDR has a non-enforceable children’s drinking water health guideline of 10 ug/L and an adult water health guideline of 40 ug/L for chromium-6.
- The levels of chromium-6 found in the finished drinking water, ambient surface water sources, or ambient groundwater sources used by Illinois CWS do not exceed ATSDR health guidelines.
- Total chromium has been detected in eight percent of the finished drinking water from CWS in Illinois. Conversely, total chromium has not been detected at 92 percent of the CWS in Illinois.
- The median concentration of total chromium in finished drinking water on a state-wide basis is 11 ug/L. In addition, the 75<sup>th</sup> percentile value is 22 ug/L.
- The median concentration of total chromium in finished water from groundwater supplies is 9.8 ug/L and 13.5 ug/L from surface water.

## Source Water Monitoring

### Ambient Lake Michigan

- The median concentration of total chromium in Lake Michigan prior to treatment is 0.5 ug/L.

### Ambient Groundwater

- The median concentration of total chromium in groundwater sources used by CWS is 8 ug/L.
- Comparing the finished water to the source water at a CWS using groundwater, yields slightly higher concentrations of total chromium at the entry point to the CWS distribution system across the state (9.8 ug/L versus 8 ug/L).
- Based on the current federal drinking water standard, the numerical Class I groundwater standard for total chromium is 100 ug/L (except due to natural causes), and it includes chromium-6.

### Ambient Lakes Other Than Lake Michigan

- The median concentration of total chromium in CWS lakes (other than Lake Michigan) is 1 ug/L.