

## Sodium in Drinking Water

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### I. Introduction

Sodium (Na) is an essential element required for normal body function including nerve impulse transmission, fluid regulation, and muscle contraction and relaxation<sup>1, 2</sup>. However, in excess amounts, sodium increases individual risk of hypertension, heart disease, and stroke<sup>3, 4</sup>. One of the chief sources of sodium is the consumption of salt; therefore salt restrictions are often recommended as a first-line of treatment for individuals suffering from these conditions<sup>5</sup>.

Sodium is found in the drinking water of all Dane County communities; including the City of Madison. Public Health Madison & Dane County occasionally receive questions from individuals expressing concern about the safety of consuming drinking water containing sodium for individuals subject to salt restrictive diets. The following document was produced to evaluate the risk of these concerns by thorough review of the scientific literature and data outlining measured concentrations of sodium in municipal water supplies of the City of Madison.

### II. Overview

#### *Impact of Excess Sodium on Human Health*

According to the United States Food and Drug Administration (US FDA), the majority of Americans consume between 4,000 to 6,000 mg of sodium per day despite the current dietary guidelines of 2,300 mg per day provided by the Centers of Disease Control and Prevention (CDC)<sup>3, 6</sup>. Excess sodium consumption results in a greater availability of sodium ions in the blood stream; leading to an expansion of blood volume due to the influence of the ion on water retention and arteriole constriction. These factors lead to a greater than normal heart activity to compensate for increased blood volume and constricted blood vessels; this condition results in thickening of the cardiac muscle and potential enlargement of the heart<sup>4</sup>. The ultimate result is an increased risk of hypertension, heart disease, and stroke; heart disease is currently the leading cause of death in the United States and stroke is third<sup>3, 7</sup>.

However, specific populations are more sensitive to the potential health impacts of excess sodium; these groups include individuals 40 years of age and older, African American, and individuals diagnosed with hypertension and/or other chronic health conditions such as Ménière's disease<sup>3, 8</sup>. Individuals that fall within these categories are encouraged to restrict salt in their diet to prevent the development of sodium-related disease or aid in the treatment of existing disease. These dietary restrictions can be as low as 500 mg per day for individuals on

therapeutic severe salt restricted diets; however, the general recommendation for individuals in high-risk categories is to consume no more than 1,500 mg per day<sup>3, 9</sup>.

#### *Sources of Sodium Consumed in the Diet*

The overwhelming majority of the sodium consumed by humans is derived from packaged, processed, store-bought and restaurant foods. In fact, the CDC estimate that approximately 77% of daily sodium intake is derived from these types of foods; an additional 11% comes from salt either added during preparation or during the meal. The remaining 12% of daily sodium intake is from naturally occurring sources including fresh fruits, vegetables, meats, and drinking water<sup>3, 10</sup>.

The major sources of sodium found in groundwater supplies across the United States is derived from the natural erosion salt deposits and sodium bearing rock minerals and the infiltration of surface waters or storm waters contaminated by road salt; additional sources may include irrigation and precipitation leaching through soils high in sodium, groundwater pollution by sewage effluent, and infiltration of leachate from landfills and/or industrial sites<sup>11, 12</sup>. In the home, additional sodium may be added to drinking water from household water softening systems. Water softeners that are recharged with salt (sodium chloride) replace hardness minerals (i.e. calcium and magnesium) with sodium to “soften” water supplies<sup>9, 12</sup>. The amount of sodium that is added is dependent upon the hardness, measured in grains per gallon (g/ gal), of the original water supply. The average hardness of water from the City of Madison Water Utility is typically 20 - 22 g/gal; at this level a water softener may increase the water sodium concentration by 160 milligrams per liter (mg/ L)<sup>13, 14</sup>. However, the kitchen cold water faucets and outside faucets are typically not softened<sup>13</sup>.

Household tap water utilized for drinking water sources should not be softened.

#### *Potential Impact of Sodium in Drinking Water on Human Health*

Currently, the United States Environmental Protection Agency (US EPA) has established a Drinking Water Equivalency Level (DWEL) of 20 mg/L for sodium in drinking water as guidance to protect drinking water quality. However, this benchmark is currently being reassessed and is considered low; a future DWEL will likely be higher than 20 mg/L. The vast majority of City of Madison wells meet the current DWEL criteria. Of the 22 active wells monitored by Madison Water Utility, only three exceed 20 mg/L.

Table 1. City of Madison Wells – Average Sodium Concentration

<b>Municipal Well No.</b>	UW #14	UW #17	UW #23	All other active wells
<b>Avg. Na concentration (mg/L)</b>	32.5	20.8	35.2	≤ 18.2

Despite the above wells exceeding the current DWEL the amount of sodium consumed from drinking water is relatively minimal and not expected to lead to any adverse health impact. For example, current recommendations encourage the consumption of eight 8oz glasses of water per day; each 8oz glass is approximately 0.25 L. Therefore, each serving of tap water from Well #23 would contain an estimated 8.8 mg of sodium (35.2 mg/L x 0.25 L); an individual who drank the recommended number of glasses of water from the same well would consume

approximately 70.4 mg of sodium each day (35.2 mg/L x 2L). The contribution of the highest reported municipal water sodium concentration to daily intake is summarized in the table below.

Table 2. Contribution to Daily Sodium Intake

Highest measured sodium concentration in the City of Madison municipal wells	35.2 mg/L
Recommended water consumption per day	2 L
Amount of sodium from drinking water per day at this concentration	70.4 mg
Percentage of daily sodium intake 2,300 mg/ day recommendation 1,500 mg/ day recommendation Salt Restrictive diets (1,500 to 500 mg/ day)	3.1% 4.7% 4.7 to 14.1%

In comparison to other commonly consumed beverages and foods, the amount of sodium in City of Madison wells is considerably low<sup>15-17</sup>.

Table 3. Average Sodium Concentrations of various products

Product <sup>a</sup>	Serving Size	Sodium Concentration (mg) per serving
UW# 14 water	8 oz	8.1
UW# 17 water	8 oz	5.2
UW# 23 water	8 oz	8.8
All other active UW water	8 oz	≤ 4.6 (range 0.6 to 4.6)
Coffee (plain)	8 oz	5
Tomato Juice	8 oz	650
Tea (unsweetened)	8 oz	5
Bottled water	8 oz	2
Coca-cola®	12 oz	50
Pepsi-cola®	12 oz	30
Sports drink	8 oz	95
White Bread	1 slice	280
Wheat Bread	1 slice	175
Tomato Soup	8 oz	950
Chicken Noodle Soup	8 oz	1,250
Hamburger (plain)	1 small	350
Hot dog (plain)	1 hot dog	650
a – The sodium concentration of commercial products are averages; actual sodium content will vary by brand. The UW water sodium concentrations are averages from analytical testing.		

## Conclusion

As indicated in the data above, the sodium concentrations in the City of Madison municipal water supplies are unlikely to cause any adverse health effects in individuals with salt restrictions. For an individual on a restrictive sodium diet that consumed 2 L of water daily, the City of Madison's drinking water would account for no more than 4.7 to 14.1% of the allotted

sodium budget dependent upon the severity of the restriction (1,500 to 500 mg per day). The usage of bottled waters as an alternative is not necessary due to the low sodium concentrations of municipal drinking water sources. However, individuals subject to severe salt restrictions should include the amount of sodium consumed from drinking water sources for more accurate sodium tracking and should avoid the consumption of “softened” water.

## References

- 1.) Mayo Foundation for Medical Education and Research (MFMER). (2008). Sodium: are you getting too much? Retrieved on August 6, 2009 from: <http://www.mayoclinic.com/health/sodium/NU00284>
- 2.) Austgen, L. (2006). The  $\text{Na}^+ - \text{K}^+ - \text{ATPase}$  (sodium pump). Retrieved on August 6, 2009 from: [http://www.vivo.colostate.edu/hbooks/molecules/sodium\\_pump.html](http://www.vivo.colostate.edu/hbooks/molecules/sodium_pump.html)
- 3.) Centers for Disease Control and Prevention (CDC). (2009). Most Americans should consume less sodium (1,500 mg/day or less). Retrieved on August 4, 2009 from: <http://www.cdc.gov/Features/Sodium/>
- 4.) Shaparenko, G. (n.d.). Sodium, your health, and your drinking water. Retrieved on August 4, 2009 from: <http://www.aquatechnology.net/frame43251.html>
- 5.) Korhonen, MH, Järvinen, RMK, Sarkkinen, ES, Uusitupa, MIJ. (2000). Effects of a salt-restricted diet on the intake of other nutrients. *The American Journal of Clinical Nutrition*, 72, 414 – 420.
- 6.) APEC. (n.d.). Water and health – will drinking water influence my sodium levels? Retrieved on August 4, 2009 from: [http://www.freedrinkingwater.com/water\\_health/health1/1-drinking-water-sodium-levels.htm](http://www.freedrinkingwater.com/water_health/health1/1-drinking-water-sodium-levels.htm)
- 7.) Centers for Disease Control and Prevention (CDC). (2009). Deaths and mortality. Retrieved on August 10, 2009 from: <http://www.cdc.gov/nchs/FASTATS/deaths.htm>
- 8.) National Institute of Deafness and Other Communicable Disorders (NIDCD). (2001). Ménière's disease. Retrieved on August 10, 2009 from: <http://www.nidcd.nih.gov/health/balance/meniere.asp>
- 9.) Kent State University. (2002). Sodium in drinking water. Retrieved on August 10, 2009 from: <http://www.oznet.ksu.edu/library/h20ql2/MF1094.PDF>
- 10.) United States Environmental Protection Agency (US EPA). (2008). Sodium in drinking water. Retrieved on August 4, 2009 from: <http://www.epa.gov/safewater/ccl/sodium.html>
- 11.) The British Columbia Ground Water Association. (2007). Sodium in groundwater. Retrieved on August 13, 2009 from: [http://www.llbc.leg.bc.ca/public/PubDocs/bcdocs/358319/sodium\\_groundwater.pdf](http://www.llbc.leg.bc.ca/public/PubDocs/bcdocs/358319/sodium_groundwater.pdf)
- 12.) Region of Waterloo Public Health. (2007). Fact sheet: drinking water, sodium and your health, in Waterloo Region. Retrieved on August 12, 2009 from: [http://chd.region.waterloo.on.ca/web/health.nsf/0/802C4278C3E2C63885256B14006407A4/\\$file/SodiumDrinkingWater\\_fs.pdf?openelement](http://chd.region.waterloo.on.ca/web/health.nsf/0/802C4278C3E2C63885256B14006407A4/$file/SodiumDrinkingWater_fs.pdf?openelement)

13.) Madison Metropolitan Sewerage District. (n.d.). Chloride. Retrieved on August 14, 2009 from: <http://www.madsewer.org/ChlorideQuestions.htm>

14.) Air and Water Quality Inc. (2000). Sodium and water softening. Retrieved on August 14, 2009 from: [http://www.awqinc.com/sodium\\_softening.html](http://www.awqinc.com/sodium_softening.html)

15.) Diet bites. (n.d). Sodium in tea, coffee, and miscellaneous drinks. Retrieved on August 12, 2009 from: <http://www.dietbites.com/Sodium-In-Foods/sodium-coffee-cocoa-tea.html>

16.) Pepsi Cola Company. (2009). Sodium. Retrieved on August 14, 2009 from: <http://www.pepsiproductfacts.com/sodium.php>

17.) The Coca-Cola Company. (2009). Nutritional information (U.S). Retrieved on August 14, 2009 from: [http://www.thecoca-colacompany.com/us\\_nutrition.html](http://www.thecoca-colacompany.com/us_nutrition.html)