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**NEW YORK STATE
- HUMAN HEALTH FACT SHEET -**

**Ambient Water Quality Value for
Protection of Sources of Potable Water**

SUBSTANCE: Cadmium

CAS REGISTRY NUMBER: 7440-43-9

AMBIENT WATER QUALITY VALUE: 5 micrograms/liter (5 ug/L)

BASIS: Specific MCL and Non-Oncogenic Effects

INTRODUCTION

The physical, chemical, and toxicological properties of cadmium have been reviewed (ATSDR, 1993; NYS DOH, 1988, 1990; US EPA, 1986, 1987, 1989, 1991, 1994; US FDA, 1993). The following ambient water quality values were derived using these and other references and the procedures outlined in 6 NYCRR 702.2 through 702.7.

SPECIFIC MCL AND PRINCIPAL ORGANIC CONTAMINANT CLASS (702.3)

Cadmium has a Specific MCL (maximum contaminant level) of 5 ug/L as defined in 6 NYCRR 700.1. The MCL for drinking water was adopted by the New York State Department of Health under the State Sanitary Code (10 NYCRR Part 5, Public Water Systems). Therefore, a water quality value of 5 ug/L (the Specific MCL) can be derived based on 6 NYCRR 702.3(a). Cadmium is not in a principal organic contaminant class as defined in 6 NYCRR 700.1.

ONCOGENIC EFFECTS (702.4)

There is limited evidence in humans and sufficient evidence in animals to conclude that inhaled cadmium can cause lung cancer (ATSDR, 1993; US EPA, 1989, 1991). Studies of humans and animals ingesting cadmium have not found increased cancer rates. However, these studies had limitations that reduced their likelihood of detecting an oncogenic effect. The available data are inadequate to evaluate the oncogenic potential of ingested cadmium (ATSDR, 1993; US EPA, 1989, 1991).

NON-ONCOGENIC EFFECTS (702.5)

Cadmium causes kidney, blood, and bone damage in humans and numerous effects in laboratory animals including liver necrosis, kidney damage, decreased bone calcium, peripheral neuropathy, testicular damage, and impaired neurobehavioral development of pups exposed in utero. Renal tubular dysfunction, initially observed as proteinuria (the presence of protein in the urine), is generally considered to be the most sensitive indicator of non-oncogenic toxicity in humans following chronic dietary exposure to cadmium (ATSDR, 1993; NYS DOH, 1988, 1990; US EPA, 1986, 1987, 1994; US FDA, 1993; WHO, 1993). The most widely accepted estimate of the critical concentration of cadmium in the renal cortex associated with proteinuria is 200 micrograms cadmium per gram of human renal cortex (200 ug Cd/gram cortex) (Falck et al., 1983; Friberg et al., 1985; Nogawa et al., 1986). This concentration is the internal dose associated with a 10% probability of renal dysfunction (i.e., low-molecular weight proteinuria) in the general population (Kjellstrom, 1985; Roels et al., 1983). In contrast, typical renal cortex concentrations in the general population of the United States (at age 50 years) range from 20 to 40 ug Cd/gram cortex (Elinder, 1985).

The NYS DOH (1988) derived an oral reference dose (equivalent to an acceptable daily intake) of 0.7 micrograms per kilogram per day (0.7 ug/kg/day) for cadmium using procedures consistent with those outlined in paragraphs (a) and (b) of 6 NYCRR 702.5. This reference dose was based on the conclusion that a kidney concentration of 40 ug Cd/gram cortex represents a level that is without appreciable risk. This latter value represents the upper end of the range of typical concentrations seen in U.S. residents and is one-fifth of the critical concentration of 200 ug Cd/gram cortex. It is equivalent to the application of a five-fold uncertainty factor to the critical cortex concentration. It is considered adequate because of the large data base on the renal toxicity of cadmium, including studies of a broad range of individuals, including the elderly, and the use of internal dose (tissue level) rather than external dose (exposure level). Because the relationship between cadmium intake and the cadmium concentration of the renal cortex is not linear, a validated kinetic model of cadmium metabolism was used to estimate the daily intake that would result in a renal cortex concentration of 40 ug Cd/gram cortex by age 50 years (the age when renal cortex concentration reaches its maximum level) (NYS DOH, 1988, 1990). This value is 48 ug Cd/day, i.e., a reference dose of 0.7 ug/kg/day for a 70-kg person. A value of 5 ug/L is derived using the procedure outlined in paragraph (e) of 6 NYCRR 702.5 and allowing 20% of the acceptable daily intake to come from drinking water (6 NYCRR 702.5(c)).

In 1988, the U.S. EPA derived an oral reference dose (equivalent to an acceptable daily intake) of 0.5 ug/kg/day for cadmium in drinking water (see Exhibit 1, taken from US EPA, 1994), using procedures consistent with those outlined in paragraphs (a) and (b) of 6 NYCRR 702.5. This reference dose (limited to cadmium in drinking water) was derived by application of a 10-fold uncertainty factor to a no-observed-effect level (NOEL) of 5ug/kg/day for significant proteinuria in humans chronically exposed to cadmium (US EPA, 1986). The NOEL was estimated using a kinetic model to determine the daily intake

necessary to reach the critical cortex concentration of 200 ug Cd/gram cortex. The U.S. EPA derived a lifetime health advisory for cadmium in drinking water of 5 ug/L assuming a 70-kg adult drinks 2 L/day and allowing 25% of the acceptable daily intake to come from drinking water (US EPA, 1987, 1991).

The Agency for Toxic Substances and Disease Registry (ATSDR), the World Health Organization (WHO), and the U.S. Food and Drug Administration (US FDA) also have used estimates of the critical cortex concentration and kinetic models of cadmium metabolism to derive values equivalent to acceptable daily intakes for cadmium. ATSDR (1993) identified the cadmium intake of 2.1 ug/kg/day as a NOEL and applied an uncertainty factor of 3 to obtain an oral minimal risk level of 0.7 ug/kg/day. The WHO (1993) identified the cadmium intake of 7 ug/kg/week as the provisional tolerable weekly intake, based on the conclusion that a renal cortex concentration of 50 ug Cd/gram cortex (about 25% of the critical concentration of 200 ug Cd/gram cortex) is without appreciable health risk. This corresponds to an intake of 1 ug/kg/day. Lastly, the U.S. FDA (1993) identified a tolerable daily intake of 55 ug/day or about 0.8 ug/kg/day for a 70-kg person, based on the daily intake of cadmium that would lead to proteinuria in 1% of the population after 45 years of exposure in food. Values of 5 ug/L, 7 ug/L, and 6 ug/L are derived using the procedure outlined in paragraph (e) of 6 NYCRR 702.5 and allowing 20% of the acceptable daily intake estimates made by the ATSDR, WHO, and U.S. FDA, respectively, to come from drinking water (6 NYCRR 702.5(c)).

The average of the five derived values is 0.7 ug/kg/day, which is equivalent to the reference dose derived by the NYS DOH, thus, a reference dose of 0.7 ug/kg/day is selected as the basis for the water quality value for non-oncogenic effects. A value of 5 ug/L is derived using this reference dose, the procedure outlined in paragraph (e) of 6 NYCRR 702.5 and allowing 20% of the acceptable daily intake to come from drinking water (6 NYCRR 702.5(c)).

CHEMICAL CORRELATION (702.7)

Deriving values based on chemical correlation is not applicable for cadmium.

OTHER STANDARDS AND GUIDELINES

Under New York State Department of Health regulations for drinking-water standards (10 NYCRR Part 5), the Specific MCL for cadmium is 5 ug/L. Under the Safe Drinking Water Act, the federal maximum contaminant level goal (MCLG) and the MCL for cadmium are both 5 ug/L (rounded from 4.4 ug/L) (US EPA, 1991), assuming a 70-kg adult drinks 2 L/day and allowing 25% of the U.S. EPA acceptable daily intake (0.5 ug/kg/day) to come from drinking water. The World Health Organization's recommended guideline for cadmium in drinking water is 3 ug/L, based on assuming a 60-kg adult drinks 2 L/day and allocating 10% of the WHO provisional tolerable daily intake (1 ug/kg/day) to drinking water (WHO, 1993).

SELECTION OF VALUE

According to 6 NYCRR 702.2(b), the selected ambient water quality value shall be the most stringent of the values derived using the procedures found in 6 NYCRR 702.3 through 702.7. This value is 5 ug/L (based on the Specific MCL and on non-oncogenic effects) and is the value selected as the water quality value for cadmium.

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SEARCH STRATEGY: ON-LINE TOXICOLOGIC DATABASE

Medline CD ROM (1989 to December, 1993) was searched linking cadmium with the keywords "neoplasms" and "adverse effects."

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