

APPENDIX A: Summation of Data on Fluoride & Bone Damage (at Exposure Levels Relevant to EPA's Current MCL)

1) Water fluoride content

EPA's current MCL of 4 ppm equals or exceeds:

- **The concentrations (1.2-1.4 ppm) found to produce skeletal fluorosis in India and China.** (SOURCE: Singh 1961; Jolly 1970; Siddiqui 1970; Xu 1997; Choubisa 2001; Bo 2003)
- **The concentrations (1.7-2.0 ppm; 1.7-2.6 ppm; 2.4-3.5 ppm) found to produce skeletal fluorosis in the US.** (SOURCE: Sauerbrunn 1965; Juncos 1972; Johnson 1979)
- **The concentrations (1.5+ ppm) found to produce mineralization defects in bone.** (SOURCE: Arnala 1985)
- **The concentrations (4 ppm) found to reduce the density of human bone.** (SOURCE: Phipps 1990; Sowers 1991)
- **The concentrations found to produce moderate/severe dental fluorosis in over 30% of children drinking the water.** (SOURCE: Dean 1942; NRC 1993).
- **The concentrations (1-4 ppm) found to increase bone fracture rates.** (SOURCE: Jacobsen 1990, 1992; Cooper 1991; Keller 1991; Sowers 1991; Danielson 1992; May and Wilson 1992; Jacqmin-Gadda 1995, 1998; Kurttio 1999; Hegmann 2000; Phipps 2000; Alarcon-Herrera 2001; and Li 2001)

2) Daily Fluoride Dose

The daily doses (8 mg/day from 2 liters of water consumption; 12 mg/day from 3 liters; 16 mg/day from 4 liters) produced at EPA's current MCL equal, exceed, or lack an adequate margin of safety for:

- **The doses (2-8 mg) estimated to cause the early stages of skeletal fluorosis.** (SOURCE: Singh & Jolly 1970)
- **The doses (2.5+ mg) estimated to produce bone damage in children with calcium deficiency in India.** (SOURCE: Teotia 1998)
- **The dose (5 mg) which the NIPHEP in The Netherlands recommend as the maximum daily intake to protect against skeletal fluorosis.** (SOURCE: NIPHEP 1989)
- **The doses (9.4-12 mg) found to cause clinical skeletal fluorosis in India, Tibet, and China.** (SOURCE: Teotia 1998; Cao 2003; Bo 2003)
- **The doses (10+ mg) which the Institute of Medicine and the National Research Council estimate cause skeletal fluorosis.** (SOURCE: NRC 1993; IOM 1997)
- **The dose (14 mg for 70 kg adult) which Health Canada estimates will cause skeletal fluorosis.** (SOURCE: Liteplo 1994)
- **The dose (14 mg) which the World Health Organization estimates will have adverse effects on the skeleton.** (SOURCE: WHO 2002)
- **The doses (14-25 mg) which Roholm estimated to cause skeletal fluorosis.** (SOURCE: Roholm 1937; Brun 1941)
- **The doses (21-25 mg) found to cause bone fractures in short-term clinical trials.** (SOURCE: Inkovaara 1975; Dambacher 1986; Hedlund 1989; Bayley 1990; Orcel 1990; Gutteridge 2002)

3) Serum fluoride content

The serum fluoride levels (up to 14.1 umol/l – SOURCE: Johnson 1979) produced at half (i.e. 2 ppm) the EPA's MCL equal or exceed:

- **The serum fluoride levels (2-5 umol/L) associated with altered bone cell activity.** (SOURCE: Farley 1983; Taves 1970; Pak 1989)
- **The serum fluoride levels (5+ umol/L) which Mayo Clinic scientists estimate could cause bone damage.** (SOURCE: Johnson 1979)
- **The serum fluoride levels (5.3-14.6 umol/L) found in humans with skeletal fluorosis.** (SOURCE: Singla 1976; Li 1986; Li 1990; Susheela 1996;. Barot 1998; Savas 2001; Yildiz 2003)
- **The serum fluoride levels (7.6+ umol/L) associated with mineralization defects in rat bone.** (SOURCE: Turner 1996; see also: Ittel 1992)
- **The serum fluoride levels (8.2 umol/L) associated with increased osteosarcomas (bone cancers) in rats.** (SOURCE: NTP 1990)
- **The serum fluoride levels (9 - 10.8 umol/L) associated with reduced bone strength in rats.** (SOURCE: Turner 1995; Turner 1996; Turner 2001).
- **The serum fluoride levels (10.5-12.1 umol/L) associated with severe dental fluorosis in an area with severe endemic fluorosis.** (SOURCE: Jin 2003).

4) Bone fluoride content

*The ***average*** bone fluoride levels (6,100-6,400 ppm; SOURCE: Zipkin 1958; Gordin & Corbin 1992) found in adults at the EPA's MCL equal or exceed:*

- **The bone fluoride levels (2,500 - 4,500 ppm) associated with reduced strength of animal bone.** (SOURCE: Mosekilde 1987; Turner 1993; Lafage 1995; Sogaard 1995)
- **The bone fluoride levels (3,400 ppm) associated with increased mineralization defects in people with kidney disease.** (SOURCE: Ng 2004)
- **The bone fluoride levels (3,500-4,000 ppm) associated with bone changes in occupational skeletal fluorosis.** (SOURCE: Franke 1975; Baud 1978)
- **The bone fluoride levels (4,570 ppm) associated with bone mineralization defects in humans.** (SOURCE: Boivin 1993)
- **The bone fluoride levels (6,000 ppm) which the US Public Health Service associates with the first clinical phase of skeletal fluorosis.** (SOURCE: PHS 1991)
- **The bone fluoride levels (6,100 ppm) found in a US citizen with crippling skeletal fluorosis.** (SOURCE: Sauerbrunn 1965)
- **The bone fluoride levels (6,000-7,000 ppm) estimated to be the "toxic threshold" by modern proponents of fluoride as a drug for osteoporosis.** (SOURCE: Zerwekh 1996)

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