

Finding #4 - The Potential for Increased Contaminant Levels Due to the Use of Hydrofluorosilicic Acid

The Fluoride Technical Study Group's (FTSG) review identified three potential concerns associated with hydrofluorosilicic acid (HFS.):

1. co-contamination (i.e. arsenic and lead),
2. decreased pH leading to increased lead solubility or exposure, and
3. potential toxicological effects from incomplete dissociation products of HFS.

Background

The City of Fort Collins has fluoridated its treated water supply since 1967. The form of fluoride added from 1967 to 1992 was called Sodium Silicofluoride, which is a dry product. As the Water Treatment Facility continued to expand, a liquid form of fluoride called Hydrofluorosilicic Acid (HFS) has been utilized since 1993. Liquid forms of fluoride are easier to handle due to the size of larger treatment facilities. The levels of fluoride are monitored carefully at the Water Treatment Facility and throughout the distribution system, and meet or exceed all recommendations set forth by the Colorado Department of Public Health and Environment (CDPHE) and the U.S. Centers for Disease Control and Prevention (CDC).

Fluoride Sources

The City of Fort Collins Utilities currently fluoridates its water with a chemical called Fluorosilicic Acid. The chemical is sometimes called Hydrofluorosilicic Acid (HFS). The term 'HFS' will be used in this report. The product is shipped to Fort Collins by truck from any one of several points in the United States. The form used in Fort Collins is typically a 23 - 24% aqueous solution of HFS (H_2SiF_6) and has a formula weight of 144.08. HFS in its full strength, non-diluted form is corrosive and requires special handling considerations. The Fort Collins Utilities complies with all special handling requirements as stated in the Material Safety Data Sheet included in Appendix 4.1.

Fluoride Manufacturing Process

All of the fluoride chemicals used in the United States for water fluoridation (sodium fluoride, sodium fluorosilicate, and HFS) are byproducts of the fertilizer industry. The process diagram of how fluorides are obtained during the manufacture of phosphoric acid is shown in Appendix 4.2, Figures 1 and 2.

Methods of Application

Fort Collins utilizes a liquid feed system to apply the optimum level of fluoride at all times. The equipment consists of the unloading station, bulk tank, day tank, pumping system, and flow measurement system. The system is monitored around the clock, 365 days per year. The amount of fluoride added is determined by measuring the background fluoride concentration in the raw (untreated) water supply. Typical background levels range from <0.15 - 0.25 mg/L of fluoride (Figure 1). Once the background levels are established, the amount of fluoride added is set to maintain the desired optimal range of 0.7 - 1.2 mg/L of fluoride. Fort Collins Utilities ensures that the amount of fluoride added is at the optimum level (1.0 mg/L) as recommended by the CDPHE and the U.S. Environmental Protection Agency (EPA). (See Report Form 1 in Appendix 4.3)

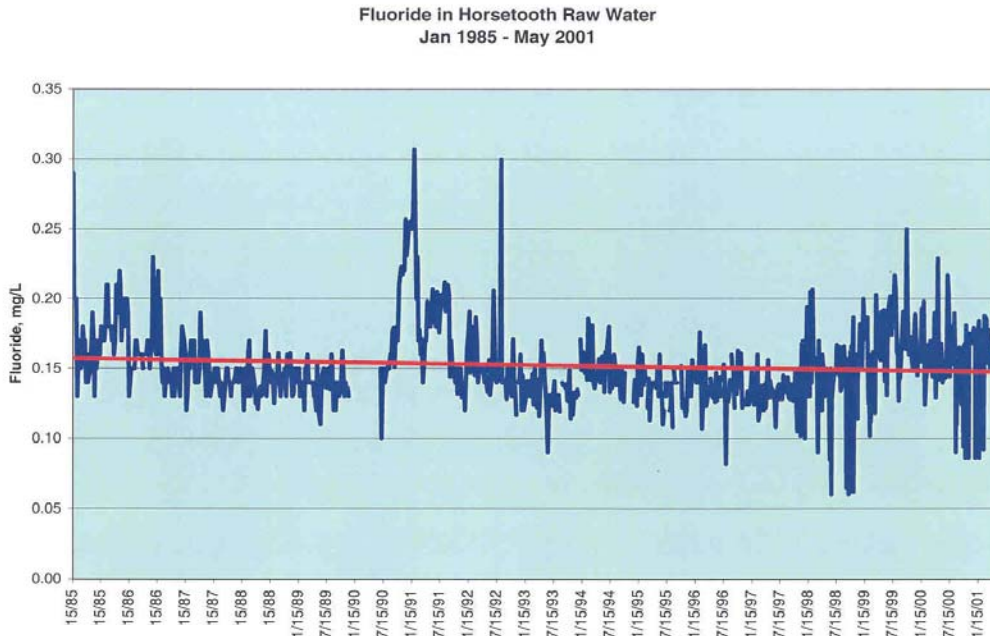


Figure 1.

Daily samples of water are measured in the City of Fort Collins Water Treatment Facility Process Laboratory (Figure 2). The analytical methods used are the specific electrode method (Standard Methods for the Examination of Water and Wastewater, 19th edition, 4500-F C). In addition to routine sampling for the raw and finished water, samples are analyzed throughout the city for many different parameters. See the Fort Collins Utilities Drinking Water Consumer Confidence Report, 2001 at <http://fcgov.com/water/pdf/wqr2001.pdf> and in Appendix 4.4). At all times, on-line monitoring equipment alert operators to any change in feed rates for chemical addition.

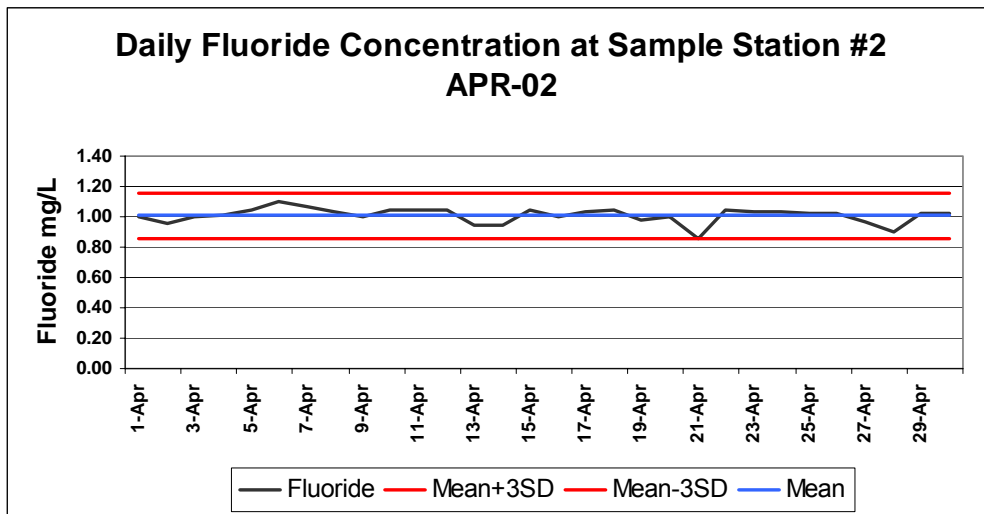


Figure 2.

Split samples are conducted on a routine basis between Fort Collins Utilities Water Quality Laboratory, the Fort Collins Utilities Process Lab and the CDPHE. The Fort Collins Utilities Water Quality Laboratory is a CDPHE and EPA certified laboratory and all data for quality assurance is reviewed on an annual basis. Results are reported to the CDPHE on a monthly basis (see Report Form 1 in Appendix 4.3).

Water Quality

The Fort Collins Water Treatment Facility uses a number of chemicals in the water treatment process to treat the raw untreated water. All of the chemicals used at the facility must meet specific industry accepted quality standards. Two of the standards utilized by Fort Collins Utilities are 1) American Water Works Association (AWWA) and 2) National Sanitation Foundation Standard 60 for Water Treatment (NSF) which can be found at www.nsf.org.

Upon receiving each load of HFS, the Fort Collins Utilities samples the product and runs a specific gravity test to verify the solution strength. Samples are stored for further analytical verification if warranted. As per industry standards, inorganic chemistry analyses are not routinely performed on each shipment. Each shipment requires a certification assuring compliance for each load (see NSF Certification in Appendix 4.4). The FTSG found that the vendor used by the City of Fort Collins meets or exceeds the standards set forth by AWWA and the NSF. In addition to chemical standards, the City of Fort Collins must comply with standards set forth by the EPA. The City of Fort Collins complies with all regulations and in many cases exceeds the minimum requirements (see Appendix 4.5 – Fort Collins Utilities Drinking Water Consumer Confidence Report, 2001 also available at <http://fcgov.com/water/pdf/wqr2001.pdf>).

Analytical Information

The FTSG reviewed data from the City of Fort Collins Water Quality Laboratory with respect to its Annual Water Quality Summary. Summaries for 2001 and 2002 are included in Appendix 4.6 and are available at <http://fcgov.com/water/pdf/2001wqt.pdf>.

Data is shown for Arsenic and Lead (Figures 3 and 4). Other parameters evaluated were Iron, Copper, Manganese, Zinc, Cadmium, Molybdenum, and Nickel. These can be found in Appendix 4.7 as Figures 3 – 9. These data represent values collected each week for a period from January 1997 - 2001. This data set was chosen for figures that are based on mean values for weekly samples for the time period indicated. Along with other water quality parameters, the FTSG reviewed each inorganic constituent in regards to trends or changes. The FTSG reviewed data for pH in the untreated and finished water and one distribution system site (Poudre Valley Hospital) as well (Figure 5).

The following graphs represent the values for the raw water, finished water, and the Maximum Contaminant Level (MCL) or the Secondary Maximum Contaminant Level (SMCL) for each parameter shown. For a description on MCL and SMCLs, please refer to the Consumer Confidence Report located in Appendix 4.

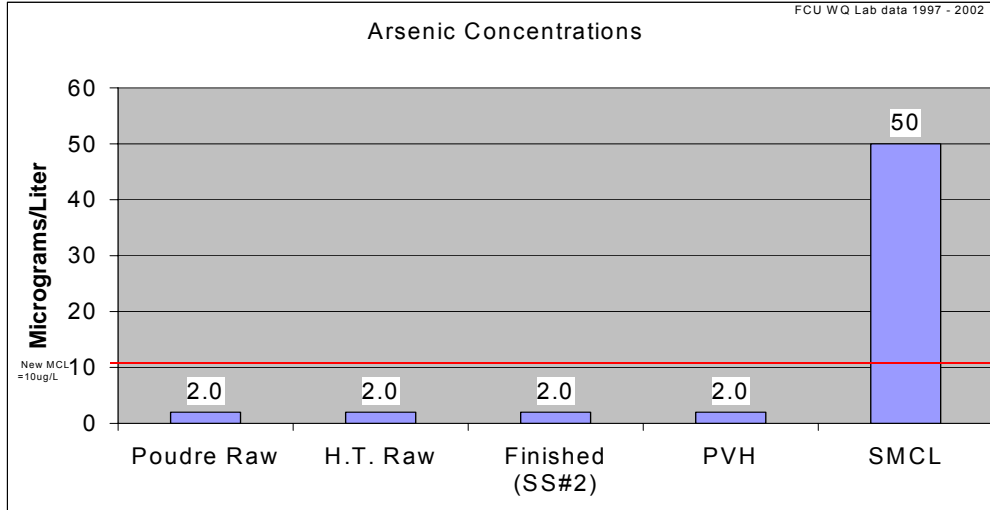


Figure 3. Arsenic

Fort Collins monitors its treated water regularly for arsenic, lead and other potential contaminants. Figure 3 shows the concentration of Arsenic (As) in both sources of raw, untreated water, the finished drinking water, Poudre Valley Hospital (PVH), and the SMCL is for arsenic. The EPA maximum concentration level for arsenic is 50 $\mu\text{g}/\text{liter}$ ¹, but has been reduced to 10 $\mu\text{g}/\text{liter}$ effective in 2006 due to the fact that arsenic is a recognized human carcinogen.

The levels of 2.0 $\mu\text{g}/\text{L}$ shown on the chart are the detection limits of the test instruments for arsenic. The concentration of arsenic in the source waters is below the detection limit for arsenic of 2.0 $\mu\text{g}/\text{L}$. The concentration in the finished water is also below the detection limit of 2.0 $\mu\text{g}/\text{L}$. Because arsenic levels are below the detection limits both before and after the addition of HFS, the actual changes in arsenic concentrations are not measurable.

In response to citizen concerns, Fort Collins Utilities had a single batch of HFS tested on May 17, 2001 using EPA Method 200.7 at the Utility's Pollution Control Laboratory. This laboratory scored 100% accuracy on all analytes of the 2001 EPA required DMR-QA "unknown" performance audit samples. In this sample, the HFS measured contained 29.0 mg/L arsenic. In addition, an analytical result from one former supplier (PENCO, Inc.), measured in 1993, indicated an arsenic concentration of 61 mg/L . The FTSG estimated the effect of the addition of arsenic contained in HSF on the concentration of arsenic in the finished water (Arsenic Concentration in Finished Water in Appendix 4.8). Using these two measures (29.0 mg/L and 61 mg/L) and conservative assumptions regarding the analytical method and the volume dilution, it was estimated that the additional contribution to the arsenic concentration in finished water is approximately between 0.10 $\mu\text{g}/\text{L}$ to 0.24 $\mu\text{g}/\text{L}$ (or 0.10 ppb to 0.24 ppb²).

¹ 50 $\mu\text{g}/\text{L}$ is approximately equivalent to 50 part per billion (50 ppb). In other words 50 $\mu\text{g}/\text{liter}$ is similar to saying the MCL is fifty "drops" of arsenic in one billion "drops" of water.

² 0.10 or 0.10 ppb is approximately equal to saying "one tenth of a "drop" of arsenic in one billion "drops" of water. The range could be interpreted as saying there is between one tenth to one quarter of a drop of arsenic in one billion drops of treated water"

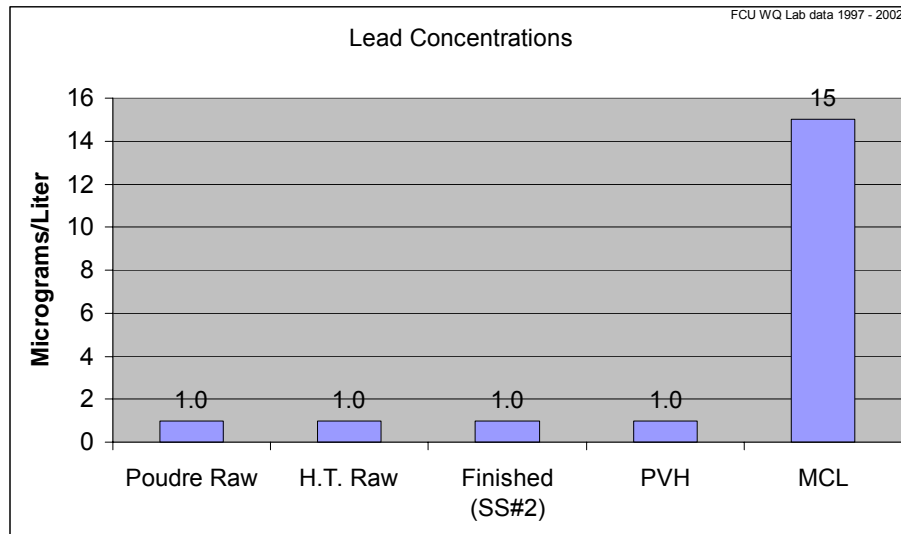


Figure 4. Lead

Lead (Pb) levels for both source waters, Fort Collins Utilities finished drinking water, Poudre Valley Hospital (PVH), and the MCL are shown in Figure 4. The concentration of lead in the source waters is below the detection limit for lead in the department's laboratory of 1.0 $\mu\text{g}/\text{liter}$. Because lead levels are below the detection limits both before and after the addition of HFS, the actual changes in lead concentrations are not measurable.

Fort Collins Utilities implemented a corrosion control program in 1983 and maintains pH levels in finished water leaving the treatment facility at values of 7.8 to 8.0 (acidic is 6.9 and lower, neutral is 7.0 and alkaline is 7.1 and above). As shown in Figure 5, the addition of HFS at the amount applied is not decreasing pH to an acidic level that could be corrosive to plumbing materials.

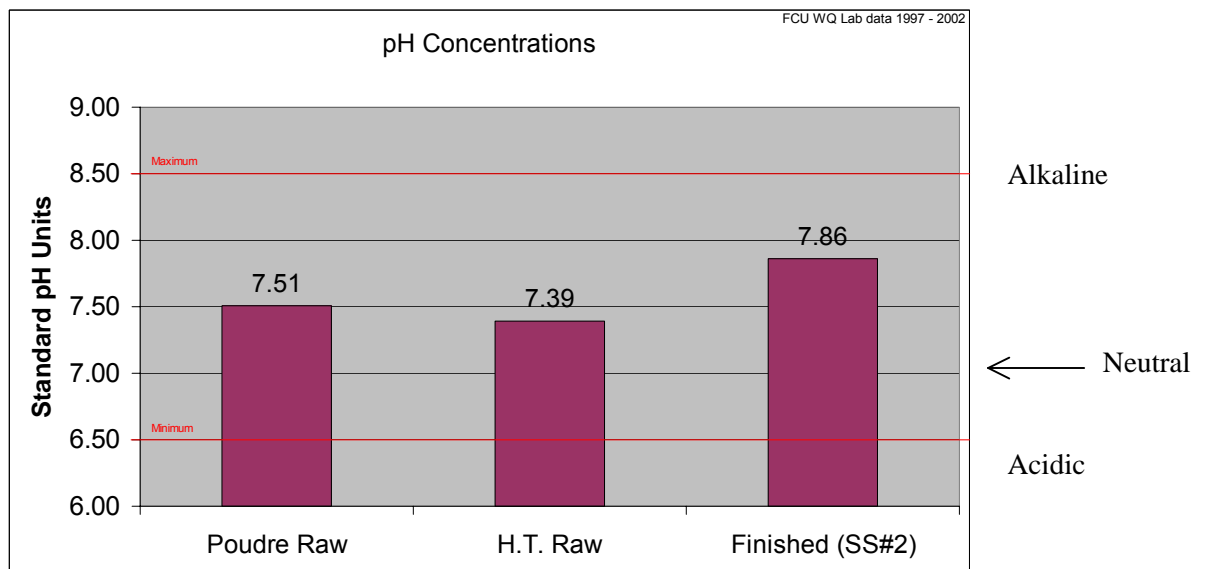


Figure 7. pH

UNCERTAINTIES

Safety of Hydrofluorosilicic Acid

Members of the public have raised concerns that HFS has not been adequately tested for safety in experimental animals since virtually all of the initial testing in animals was done with sodium fluoride. The National Toxicology Program (NTP) continuously solicits and accepts nominations for toxicological studies to be undertaken by the program on substances of potential human health concern. Nominations can come from Federal agencies, industry, the public, and other interested parties and undergo several stages of review before selections for testing are made. Possible public health consequences of exposure are the overriding factors considered in selecting substances. Nominations are first reviewed internally and toxicological summaries based on an extensive literature review are prepared. The summary is then distributed to the NTP Interagency Committee for Chemical Evaluation and Coordination (ICCEC). The ICCEC is composed of representatives from the Agency for Toxic Substances and Disease Registry, the Consumer Product Safety Commission, the Department of Defense, the Environmental Protection Agency, the Food and Drug Administration's National Center for Toxicological Research, the Occupational Safety and Health Administration, the National Cancer Institute, the National Institute of Environmental Health Sciences, the National Institute for Occupational Safety and Health, and the National Library of Medicine. Evaluation by the ICCEC is the initial external review step. The ICCEC makes testing recommendations and priorities. These recommendations are presented to the NTP Board of Scientific Counselors (BSC) for review and comment in an open public session. The BSC's recommendations are then submitted to the NTP Executive Committee for review and final approval (Federal Register: March 2, 2000, Volume 65, Number 42, pp. 11329-11331).

HFS was nominated to the NTP by Mr. Coplan (of Masters and Coplan) and other private individuals in 2001 for "chemical characterization, toxicological characterization including chronic toxicity, carcinogenicity, neurotoxicity, and toxicokinetics, [and] mechanistic studies related to cholinesterase inhibition and lead bioavailability." According to the toxicological summary for nomination, "Sodium hexafluorosilicate and fluorosilicic acid were nominated for toxicological testing based on their widespread use in water fluoridation and concerns that if they are not completely dissociated to silica and fluoride in water that persons drinking fluoridated water may be exposed to compounds that have not been thoroughly tested for toxicity." On April 17, 2002, the ICCEC recommended, "chemical characterization studies to assess chemical fate under aqueous conditions. Toxicological studies may be considered when results of chemical characterization studies are available for review" (Federal Register: June 12, 2002, Vol. 67, No. 113, pp. 40329 -40333). The nomination is now in the hands of the NTP Board of Scientific Counselors.

The public concern that HFS has not been tested for toxicity can be addressed by a better understanding of the chemical fate of fluorosilicate drinking water additives as presented by a review by Urbansky in 2002. Quickly upon addition to water supplies, HFS reaches an equilibrium where, according to Urbansky (2002, p. 2843), "the hexafluorosilicate molecule is totally decomposed to a silicic acid molecule, four hydrogen cations and six fluoride anions." Furthermore, the "dissolved silica contribution of the fluoridating agent is trivial compared to the native silica" (Urbansky, 2002, p. 2844). Complicated fractional distribution plots for fluoride species as a function of pH presented by Urbansky (2002) illustrate the proportion of each species at equilibrium. The conclusion drawn by Urbansky from a review of these diagrams are that "The concentration of any fluorosilicate species is extremely small at drinking water pH" (Urbansky, p 2844). For example:

"It is concluded that in any drinking water supply with a pH of 5 or higher, fluoridated with sodium silicofluoride [HFS] to the extent of 16 ppm of F or less, all of the silicofluoride is completely hydrolyzed to silicic acid, fluoride ion, and hydrogen fluoride. There can be no question of toxicity of SiF₄ or SiF₆²⁻ under such conditions" (Urbansky, pp. 2844 & 2845).

While Urbansky states (2002, p. 2850) that, "The kinetics of the dissociation and hydrolysis of hexafluorosilicate are poorly understood from a mechanistic or fundamental perspective." the take home message by Urbansky for non-chemists is that, "the rate data suggest that equilibrium should have been achieved by the time the water reaches the consumer's tap if not by the time it leaves the waterworks plant" (Urbansky, 2002, p. 2850). So while further research is being conducted on this subject, Urbansky states on page 2851, "we must try to make the best use of the information available to us and focus on the consistencies as well as what is unequivocally established as chemical fact." The Urbansky review suggests that fears over HFS and the unknown toxicity of any resulting fluoride species as the HFS quickly dissociates to fluoride ion and the other chemical species may be unfounded when the fundamental chemical facts are considered.

On April 25, 2002, the EPA released a request for research on the hexafluorosilicates in a Request For Assistance (RFA).

"The primary objective of this RFA is to investigate the reactions that take place when fluorosilicates are added to drinking water supplies and what concentrations of which fluorosilicate species may be monitored in finished drinking water supplies and what techniques may be used for such monitoring" (The RFA is issued under the name of Edward T. Urbansky, U.S. EPA, National Risk Management Research Laboratory Water Supply and Water Resources Division).

Potential for Increased Absorption of Lead

Studies published in 1999 and 2000 of 280,000 children in Massachusetts and 151,000 children in New York showed an increase in the prevalence of blood lead concentrations in children's blood in communities in which fluorosilicates [HFS] were used for community water fluoridation (Masters & Coplan, 1999; Masters, Coplan, Hone, & Dykes, 2000). The increases were from 1.9% above 10 $\mu\text{g}/\text{dl}$, to 2.9% above 10 $\mu\text{g}/\text{dl}$. The 1999 study (Masters & Coplan) concluded "the fluoridation agents used in water treatment have a major effect on lead levels in children's blood." They found that lead levels were significantly lower in communities that used sodium fluoride, or did not fluoridate, than those who used silicofluorides (SiF) such as hydrofluorosilicic acid (Masters & Coplan, p. 440).

The study published in 2000 concluded, "For every age/race group, there was a consistently significant association of SiF treated community water and elevated blood lead." In addition, they found poor black children in old housing to be at a higher risk of elevated blood lead if their community provided silicofluoride-treated water (Masters, Coplan, Hone, et al., 2000).

Because of the ecologic design of the Master's studies, the possibility that the findings are due to confounding cannot be ruled out. The data show that 49.4% of the homes in communities treated with silicofluorides were built before 1939. Conversely, 23.3% of the homes in the communities not treated with silicofluorides were built before 1939. Similarly, 22.3% of the children in silicofluoride-treated communities were below the poverty level while 8.5% of children in non-silicofluoride treated communities were below the poverty level. The method of analysis in the Masters, Coplan, Hone, et al (2000) paper relied on classifying covariates as above and below the median for each risk factor, potentially resulting in misclassification of exposure to the confounder (e.g. poverty) by inclusion of large numbers of subjects in the category considered exposed to the confounder. In addition, the age of the house in which the child resided and the age of the water distribution system infrastructure would be expected to differ across communities characterized by differences in age of housing. There is therefore a possibility of differences in lead containing piping through the distribution system. There also may be differences in exposure to household sources of lead. For example, the increased tendency of poor or malnourished children to chew on objects such as window-sills, to eat dirt, and to mouth objects

potentially contaminated with lead flakes from chipped paint. These differences are not accounted for in the analysis and may have been responsible for the differences observed in blood lead concentrations.

A possible mechanism proposed by Masters and Coplan (1999, p. 437) for the putative increase in lead is the lowering of drinking water pH by addition of HFS (a strong acid) in poorly buffered water supplies leading to a pH dependent increase in lead solubility (Stumm & Morgan, 1996). This mechanism is only plausible for poorly buffered water supplies such as those studied by Masters et al. The Fort Collins water supply is maintained at a well buffered pH greater than 7 (neutral to alkaline), as shown in figure 5, and as such lead solubility should not be increased through the addition of small amounts of HFS. To the extent that the mechanism of lead increase is due to HFS induced changes in pH and therefore lead solubility, Fort Collins drinking water lead concentrations are not susceptible to this reported side effect of HFS addition.

No other plausible biological/chemical mechanism for the source of the increases in blood lead has been proposed in the literature. Studies with stronger designs would be needed to fully address any remaining uncertainties.

The Medical Research Council of Great Britain stated the following:

“Two recent studies (Masters & Coplan, 1999; Masters, et al., 2000) have found an association between ingestion of drinking water treated with silicofluorides and elevated blood lead in children... However, according to the US EPA there is no substantive evidence to suggest that fluoridation of drinking water with any fluoridating chemical increases the concentration or bioavailability of lead in drinking water via chemical reactions in the plant, the distribution system, the home plumbing system, or the human body itself (Urbansky & Schock, 2000). This appears to be a controversial area and further studies are awaited” (Medical Research Council Working Group, 2002, p. 36).

Peer review of the Masters and Coplan report, coming at the request of US EPA and Urbansky, has confirmed Urbansky and Schock’s critique. The peer review letters are included as Appendix 4.X to this report.

Lead Levels in Colorado Children

The issue raised by a pair of papers by Masters and Coplan - that exposure to HSF in drinking water might be a risk factor for elevated lead levels in children - could make information regarding the prevalence of elevated blood lead levels in children in our area relevant to decision makers. The Colorado Board of Health recommends that all low-income children in Colorado should be routinely screened for blood lead levels at 12 months and 24 months of age or between the ages of 36 months and 72 months of age if they have not been previously screened (Colorado Childhood Blood Lead Screening Plan, CDPHE, 2001). Low-income children are identified as children eligible for Medicaid, Child Health Plan Plus, or the Colorado Resident Discount Program, and children residing in certain areas in Denver found to be high risk. A report released in April 2002 by the Colorado Department of Public Health and Environment Lead Poisoning Prevention Program reports that the proportion of children with one or more elevated blood lead levels (≥ 10 mcg/dl) in the period 1/1996 through 12/2001 was 1.5% (95% C.I., 0.8%-2.1%) in Larimer County, one of the lowest proportions among the ten largest counties in Colorado (see Table 1). Statewide, the proportion of children tested who were found to have elevated blood lead levels was 2.7% (95% C.I., 2.5%-2.9%) during this period. It is important to note that this data represents only a fraction

of children defined as high risk³ and may not be representative of all low-income high risk children. However, the proportion of *all* children in our community with elevated lead levels would be expected to be lower than those reported above. Masters and Coplan reported elevated lead levels from a survey of children 0-6 years old in Massachusetts in 1991, based on the fluoridation status of community of residence. Lead levels were elevated in 3.0%, 2.9%, 1.6% and 1.9% of communities fluoridated with silicofluoride compounds (SFC), hydrofluorosilicic acid (HFS), sodium fluoride and no fluoride, respectively.

Mean lead levels have been decreasing since the late 1970s attributed primarily to the phase-out of leaded gasoline. A national sample of children ages 1 to 5 years found a decrease from 2.7 (95% C.I., 2.6-2.9) mcg/dl in 1991-94 to 2.0 (95% C.I., 1.7-2.3) in 1999 (MMWR. 49(50):1133-7, Dec 2000).

In recent years the most common source of lead in children with elevated lead levels is from lead based paint that is poorly maintained in older homes. Low-income children living in older housing have been found to be at much higher risk of elevated blood lead levels than other children (CDC, Blood lead levels in young children—United States and selected states, 1996-1999, MMWR 49(50):1133-7). In Larimer County (see Table 1) there are a relatively low proportion of residences deemed high-risk—defined as “housing unit built before 1950 and occupied by a low income family” (based on 1990 US Census data, see <http://www.scorecard.org/>).

Table 1
Blood Lead Levels In Colorado Counties, 1996-2001

County	# ≥10 µg/dl ^a	Total tests ^a	% ≥10 µg/dl	Est. 95% C.I. ^b	% of 6-72 month olds screened ^a	% of housing units with high-risk of lead hazards ^c	% of population on FI water ^d	% of population on HFS or SFC ^d
Adams	20	546	3.7%	2.1%, 5.2%	0.4%	0.7%	15%	11%
Arapahoe	48	1787	2.7%	1.9%, 3.4%	1.1%	0.3%	64%	64%
Boulder	17	563	3.0%	1.6%, 4.4%	?	1.4%	92%	90%
Denver	461	17362	2.7%	2.4%, 2.9%	7.8%	5.7%	100%	100%
ElPaso	26	1849	1.4%	0.9%, 1.9%	1.3%	1.2%	8%	3%
Jefferson	20	798	2.5%	1.4%, 3.6%	0.7%	0.4%	44%	43%
Larimer	20	1376	1.5%	0.8%, 2.1%	3.4%	1.7%	95%	94%
Mesa	14	471	3.0%	1.4%, 4.5%	2.6%	2.7%	98%	98%
Pueblo	34	972	3.5%	2.3%, 4.7%	1.8%	6.4%	89%	87%
Weld	74	2518	2.9%	2.3%, 3.6%	2.4%	3.8%	76%	74%

^a Childhood Lead Poisoning in Colorado, Colorado Department of Public Health And Environment, April 2002 (<http://www.cdph.state.co.us/dc/Lead/survbullet2.PDF>)

^d 95% confidence intervals were calculated using a normal approximation to the binomial distribution assuming a random sample of n = “total tests”.

^c Environmental Defense Fund, Scorecard, Colorado Counties (<http://www.scorecard.org/>), based on 1990 Census data.

^d Personal Communication, Dan Felzien, Fluoride Engineer, Colorado Department of Public Health and Environment, 3/2003. HFS: hydrofluorosilicic acid; SFC:silicofluoride compounds.

³ In the 3rd quarter of 2001 in Larimer County, approximately 3,725 of 18,527 6-72 month olds met the definition of high-risk based on Medicaid or CHP enrollment (20%). Of these about 1,850 would have been eligible for a lead test in 2001 (became either 12 or 24 months of age). However only 622 children were screened (34%).

The data for statewide blood levels exceeding 10 µg/dl are important to the considerations by the FTSG and decision makers for several reasons:

1. They provide information about childhood blood levels and community water fluoridation and other conditions that may affect blood lead that are relevant to our local conditions. Local conditions include age of housing, use of lead piping in distribution and household water systems, use of lead paint, and socio-economic and demographic factors.
2. The data from CDPHE can be screened on an ecologic basis, similar to the approach taken by Masters and Coplan (1999, 2000) in their analyses of blood lead in Massachusetts, New York and elsewhere. Masters and Coplan conducted their analyses at the community level (not on individuals). In Colorado, the analysis is done at the county level with the available data.

From a qualitative basis, there is a lack of association between community water fluoridation with HFS and the percent of children with blood lead > 10 µg /dl. The highest prevalence of elevated blood lead is seen in Adams County (3.7%) where 11% of the population receive HFS fluoridated water. Larimer County and El Paso County have the lowest prevalence of elevated blood lead (1.4% and 1.5%, respectively). El Paso County (containing Colorado Springs) has high naturally occurring concentrations of fluoride in their water supply and most communities within the county (including Colorado Springs) do not use community fluoridation. Larimer County, similar in many aspects to El Paso County (e.g. the percent of housing with high risk lead hazards is 1.7% and 1.2%, respectively) also has a very low prevalence of elevated blood lead, and provides 94% of its population with water fluoridated with HFS.

Qualitatively, there is a lack of relationship between community fluoridation with HFS and blood lead in the data for these two counties. The lack of relationship between HFS and blood lead in these two counties would not be expected to occur if the hypothesized association as postulated by Masters and Coplan was causal.

From a quantitative perspective, the data in Table 1 can be subjected to regression analyses to determine whether there is evidence of a statistical association between child blood lead and use of HFS at the county level. The results of our analyses are provided in Appendix 4. The r-squared value provides a measure of the variation in the dependent variable (prevalence of elevated blood lead) explained by the independent variable (% HFS treated water or % of housing units with high-risk lead hazards). The county analysis for percent of population supplied by HFS shows no relationship (r-squared = 1.9%, $p > 0.7$). The analysis for % of housing units with high-risk lead hazards also shows very little correlation (r-squared = 8.8%, $p > 0.4$). When both variables are placed in the model, the r-squared is 8.9%, $p > 0.7$. The partial correlation coefficient was calculated to estimate the degree of correlation between elevated blood lead and the % of population supplied by HFS, controlling for % of housing units with high-risk lead hazards. This analysis shows no significant correlation (r-squared = 0.12%, $p > 0.9$) between elevated childhood blood lead and percent of the population receiving HFS treated water in Colorado counties. These data have been adjusted for potential confounding by the percent of housing with high-risk lead housing in each county. There were no data available to evaluate other potential confounders such as age and race.

FINDINGS: The Potential for Increased Contaminate Levels Due to the Use of Hydrofluorosilicic Acid

The FTSG's review identified three potential concerns associated with hydrofluorosilicic acid (HFS): 1.) co-contamination (i.e. arsenic and lead), 2.) decreased pH leading to increased lead solubility or exposure, and 3.) potential toxicological effects from incomplete dissociation products of HFS. The FTSG used the raw and finished water quality data for the City of Fort Collins to determine whether the addition of HFS was responsible for the potential addition of contaminants such as heavy metals to the city's drinking water. There was no evidence that the addition of HFS increased the concentrations of copper, manganese, zinc, cadmium, nickel, or molybdenum. The concentrations of arsenic and lead were below the detection limit for the Fort Collins Water Quality Control Laboratory in both the source water and the finished water and below the maximum contaminant level (MCL) for these naturally occurring elements. There was no evidence that the introduction of HFS changed the pH of the water appreciably. Concern that HFS incompletely dissociates may be unfounded when the fundamental chemical facts are considered. Therefore, it is unlikely that community water fluoridation poses a health risk from the exposure to any of these chemicals present in the water as it leaves the plant. Further studies related to the health effects of HFS are in progress.

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