Petitioned Health Consultation

CORAL SPRINGS

CORAL SPRINGS, BROWARD COUNTY, FLORIDA

OCTOBER 24, 1997

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members.

This document has previously been released for a 30 day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The health consultation has now been reissued. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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PETITIONED HEALTH CONSULTATION

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Prepared by:

Petition Response Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

BACKGROUND AND STATEMENT OF ISSUES

A private citizen in the city of Coral Springs, requested the Agency for Toxic Substances and Disease Registry (ATSDR) to review drinking water data and determine if contaminants are present and at concentrations of public health concern. U.S. Census data for 1990 reported that Coral Springs in Broward County, Florida, had a population of 79,443 and 27,014 households. The median age was 31.6 years, with 31% of the population less than 18 years and 7.0% 65 years and over. The median price owner-occupied housing unit was $160,200, and median family income was $49,856. The data reported the following distribution: white (86%), Hispanic origin (7.1%), black (3.5%), Asian or Pacific Islanders (2.1%), American Indian, Eskimo, or Aleut (0.2%), and other (1.1%). Coral Springs area residents receive drinking water from blended groundwater tapped from four wells at 130 feet deep. The water is treated, tested for chemical and microbial contaminants, and distributed to area residences through either the North Springs Improvement District or the Royal Utilities Rainbow Management Distribution System.

ATSDR staff met with community members on May 19, 1997, to discuss health concerns. Community members have expressed concern over a multitude of health ailments including cancer (breast, colon, skin, throat, brain, stomach, prostate), dizziness, low blood pressure, burning sensations (skin, stomach, ovaries), distention, unexplained weight loss, vertigo, ear problems (ringing, clicking, whirring), hormone problems, hair falling out, shortness of breath, respiratory problems, nausea, vomiting, severe problems with monthly cycles (women), unexplained bleeding, swelling of lymph nodes, passing out, intense sweating, severe headaches, pain (neck, lower back, joints), muscle weakness (shoulders, arms, legs, ankles), tongue coating, growths and death (residents, pets). Community members strongly believe that contaminants in their drinking water have resulted in these adverse health ailments.

Sampling of the public water distribution system took place on several occasions. Water samples were tested for all the priority pollutants or pollutants defined in the Code of Federal Regulations 40, Part 141, including volatile organic compounds, organic compounds to include pesticides, and metals. Water samples from the North Springs Improvement District distribution system were collected and analyzed in June 1996 (1). The United States Environmental Protection Agency (EPA) contracted Precision Environmental Laboratories, Inc. to perform an ammonia nitrogen test on several water samples collected in January 1997 (2). The Broward County Health Department collected and analyzed unfiltered water samples on January 16 and 29, 1997, from residential water taps in Coral Springs (3). Table 1 presents the results of these sampling events. (See Appendix A for definitions of the comparison values in Table 1).

Table 1: Public Water Well Data				
Contaminant	**Maximum Concentration ppb**	**Qualifier**	**Comparison Value***	
			Value ppb	Source
Aluminum	47		50 to 200	EPA SMCL
Arsenic	0.54	I	0.02	CREG
			3	Chronic EMEG (child)
			50	MCL
Bromodichloromethane	3.1	I,Y	0.6	CREG
			200	Chronic EMEG (child) pMCL = 100 ppb
Calcium	30,000		None	
Chloride	61,000		250,000	EPA SMCL
Chloroform	22	Y	6	CREG
			100	Chronic EMEG (child) pMCL = 100 ppb
Chloromethane	0.22	T	3	LTHA
			400	CLHA
Copper	7.5		1,000	EPA SMCL MCLG = 1,300 ppb
Dibromochloromethane	0.41	I,Y	0.4	CREG
			300	Chronic EMEG (child) pMCL = 100 ppb
Fluoride	960		4,000	MCL (Fluorine)
Iron	120**		11,000 ppb	EPA III RBC
Magnesium	6,000		None	
Manganese	0.29	I	50	EPA SMCL
Nickel	1.2	I	100	LTHA, MCL
Nitrate	70		20,000	RMEG (child)
			10,000	MCL

Table 1: Public Water Well Data				
Total Nitrate and Nitrite	60		10,000	MCL
Nitrogen (ammonia)	930		3,000	Intermediate EMEG (child)
			30,000	LTHA
Sodium	33,000		20,000	Recommended Max.***
Sulfate (total)	53,600**		500,000	pMCL
Zinc	60**		3,000	Chronic EMEG (child)

TABLE KEY:

* explanation of comparison values in Appendix A
** well water sample (concentration detected before treatment)
*** American Heart Association.
ppb = parts per billion
pMCL = proposed maximum contaminant level (Appendix A)
I = approximate value between detection level and quantitation level
T = approximate value less than the method detection level
Y = analysis from unpreserved or improperly preserved samples; result suspect

ATSDR relies on the environmental data in the referenced documents to prepare health consultations. ATSDR staff assumes adequate quality assurance and quality control measures were followed regarding chain-of-custody, laboratory procedures, and data reporting, including adequate detection limits, appropriate sampling methods, and sample holding times. A review of available data from the laboratory reports utilized in this health consultation indicated appropriate quality assurance and quality control measures were followed.

DISCUSSION

None of the reported substance concentrations exceed either current maximum contaminant Levels (MCLs), which are EPA's legally enforceable drinking water standards (4, 5), or ATSDR's comparison values for chronic, noncancer effects in children. The latter values are ATSDR's most conservative comparison values for noncancer effects. Only the agency's cancer risk evaluation guides (CREGs) are more conservative. Comparison values are typically orders of magnitude lower than levels known to cause adverse health effects in animals or humans.

Except for the chlorination by-products chloroform, bromodichloromethane (BDCM), and dibromochloromethane (DBCM), all of the substances found in public well water in Coral Springs (Table 1) are normal constituents of the natural environment. Many of these, including copper, zinc, fluorine, iron, magnesium, manganese, calcium, and sodium, are not only relatively nontoxic, but are also essential nutrients required in comparatively large amounts (1-100 or more milligrams per day) for the maintenance of normal function and good health. (Nickel and arsenic are required in trace amounts in animals, and maybe in humans as well.) Because of the nutritional importance of these substances, the body employs homeostatic mechanisms that maintain relatively constant levels of them in the blood, even though dietary intakes vary substantially (6). These homeostatic mechanisms increase retention when the intake is low and increase elimination and/or sequestration when intake exceeds the body's needs. As a result, nutritional deficiency of these substances is uncommon and toxicity resulting from excess dietary intakes is even rarer, usually requiring the ingestion of very large amounts (6). Because toxicity by the oral route is so unusual, ATSDR does not even have health-based comparison values for most of them. That is why the secondary maximum contaminant level (SMCL) is used as a comparison value for several of the substances listed in Table 1.

The maximum detected concentration of sodium (33,000 parts per billion (ppb)) marginally exceeded the American Heart Association's recommended maximum level of 20,000 ppb in drinking water (Table 1). However, based on the default assumption that adults drink 2 liters of water per day (i.e., approximately eight 8-ounce glasses of water per day), the resulting daily intake (66 milligrams) would still be less than 15% of the Food and Drug Administration's recommended dietary allowance and less than 3% of the lowest level at which adverse effects have been observed (6). Therefore, this concentration would not likely present a health problem.

Arsenic, BDCM, chloroform, and DBCM were present in Coral Springs drinking water at levels that exceeded ATSDR's CREGs for those substances. However, at the concentrations detected (Table 1), none of these drinking water contaminants pose a realistic cancer hazard to humans. ATSDR's CREGs are the most conservative, theoretical, and assumption-laden of the agency's comparison values. They are based on numerical cancer risk estimates that, in turn, are based on conservative policy assumptions that do not always apply to real world situations. These conservative assumptions ensure protection of the public health in the face of major uncertainties; however, they do not provide a basis for the prediction of actual adverse health effects in humans. As stated in EPA's 1986 Carcinogen Assessment Guidelines, "the true risk is unknown and may be as low as zero". Thus, the mere existence of a CREG for a substance in no way implies that low levels of that substance (e.g., 10 to 100 times higher than the CREG) will, in fact, be carcinogenic to animals or humans. CREGs, and the numerical risk estimate on which they are based, must be interpreted in the context of the variables and assumptions involved in their derivation and in the broader context of biomedical opinion, host factors, and actual exposure conditions.

Arsenic:

The maximum level of arsenic detected in Coral Springs drinking water (0.54 ppb) exceeded ATSDR's CREG of 0.02 ppb, but was far below any level known to cause adverse health effects. Studies of arsenical skin cancer in a nutritionally-compromised, Taiwanese population with prolonged exposure to high levels of arsenic in groundwater (170 > 800 ppb), in addition to other dietary sources that were inadequately accounted for, provide the primary basis of ATSDR's CREG for arsenic in drinking water. However, several epidemiological studies in the U.S., where nutritional status is better, sources of food and water are more varied, and arsenic concentrations are lower, have failed to show any association between arsenical skin cancer and arsenic in groundwater (7, 8). Furthermore, both carcinogenic and noncarcinogenic effects of arsenic in humans appear to require daily exposure in excess of an apparent threshold of about 400 micrograms per day (µg/day) (9). Because effective inorganic arsenic detoxification pathways exist in the body, blood arsenic levels do not even begin to rise in response to increased exposure until the intake exceeds about 200 µg/day. The later intake rate would correspond to a drinking water level of 100 ppb, assuming consumption of 2 liters of water per day. There is even some evidence to suggest that arsenic (at approximately 16 to 50 µg/day) is an essential trace nutrient with anticancer value in humans as well as animals (10).

Chlorination By-Products:

While BDCM, chloroform, and DBCM did not exceed either current MCLs or ATSDR's comparison values for chronic, noncancer effects in children, they were present at levels that exceeded ATSDR's CREGs for those substances. The residues of chloroform, BDCM, and DBCM detected in Coral Springs drinking water appear to be chlorination by-products which, ATSDR does not consider a significant health hazard of any kind at the levels indicated.

The assumption that these chlorination by-products may be carcinogenic to humans is largely based on the observation that very high, toxic or near toxic doses of these substances administered in oil by gavage, produced sex and species-specific tumor responses in the livers, kidneys and/or large intestines of mice and rats at doses that were probably toxic to those organs (11-13). The doses required to induce cancer were 100,000 to a million times higher than the doses that Coral Springs residents are likely to receive from their drinking water. More important, however, the weight of currently available evidence suggests that very high doses of these same chemicals (i.e., doses similar to or only slightly lower than those doses that were carcinogenic in the gavage studies) will not cause cancer in rodents when they are administered in drinking water *ad libitum*, i.e., allowing the animals to drink freely and as much water as they desire, the way humans are exposed (14-17). Depending on whether it labels the relevant animal data as sufficient or limited, the International Agency for Research on Cancer classifies individual chlorination by-products as either Group 2B, possibly carcinogenic to humans (chloroform and BDCM) or Group 3, not classifiable as to human carcinogenicity (DBCM).

A few studies have identified a weak association between low increases of bladder and/or colorectal cancer and exposure to chlorinated drinking water (17). However, because of the methodological limitations inherent in these studies (e.g., inadequate data on actual exposures and on the distribution of confounding factors), no direct link between specific chemicals in the water and observed health effects can be inferred from the data with any confidence. The small differences observed in these studies could merely reflect a slightly higher prevalence of certain known risk factors having nothing to do with the drinking water *per se* (e.g., occupational exposures, smoking, diet, urban versus rural lifestyles, etc.) in communities with chlorinated drinking water, compared to those without chlorination.

In any case, the hypothetical health risks that may be associated with chlorination of drinking water are trivial by comparison to the very real risks of waterborne, microbial diseases that chlorination has controlled so effectively for nearly a century. Chlorination of drinking water is the most successful public health measure ever instituted and chlorine has probably saved more lives than any other single chemical in history (17).

Combined Effects:

The concentrations in drinking water of the substances listed in Table 1 are of no public health concern, either individually or in combination. Research to date has shown that mixtures of chemicals do not produce adverse effects when the concentrations of the individual components are lower than their respective no-adverse-effect levels (NOAELs) (18-23). Synergistic effects would not, therefore, be a plausible health concern with regard to the chemicals that Coral Springs drinking water was reported to contain, because the concentrations of all those substances were below the relevant NOAELs by several orders of magnitude (Table 1).

CONCLUSIONS AND RECOMMENDATION

Based on the available evidence, none of the adverse health effects described in the statement of concerns appear to be plausibly related to the chemicals detected in the drinking water (Table 1). The levels of all these substances were well below the relevant Environmental Protection Agency drinking water standards and Agency for Toxic Substances and Disease Registry (ATSDR) comparison values for chronic, noncancer effects. Although the levels of arsenic, chloroform, bromodichloromethane, and dibromochloromethane did exceed ATSDR's cancer risk evaluation guides for those compounds, all were well below levels likely to be carcinogenic in either animals or humans. Assuming that the currently available data are both accurate and representative, ATSDR considers that no adverse health effects of any kind are likely to result from drinking any amount of water containing these compounds at the levels detected and recorded in Table 1; the agency, therefore, recommends no further action at this time.

In the absence of additional supporting data, ATSDR cannot speculate about what else the drinking water may contain, what the local incidence of various diseases may actually be, or what the specific causes of individual health problems are. However, should more extensive water analyses be made available to ATSDR, agency staff would review that data and, if necessary, make further recommendations to ensure public health.

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APPENDIX A - Comparison Values

ATSDR comparison values are media-specific concentrations that are considered to be safe under default conditions of exposure. They are used as screening values in the preliminary identification of site-specific "contaminants of concern." The latter term should not be misinterpreted as an implication of "hazard." As ATSDR uses the phrase, a "contaminant of concern" is merely a chemical substance detected at the site in question and selected by the health assessor for further evaluation of potential health effects. Generally, a chemical is selected as a "contaminant of concern" because its maximum concentration in air, water, or soil at the site exceeds one of ATSDR's comparison values.

However, it must be emphasized that comparison values are not thresholds of toxicity. While concentrations at or below the relevant comparison value may reasonably be considered safe, it does not automatically follow that any environmental concentration that exceeds a comparison value would be expected to produce adverse health effects. The whole purpose behind highly conservative, health-based standards and guidelines is to enable health professionals to recognize and resolve potential public health hazards before they can become actual public health consequences. Thus, comparison values are designed to be preventive, rather than predictive, of adverse health effects. The probability that such effects will actually occur depends, not on environmental concentrations alone, but on a unique combination of site-specific conditions and individual lifestyle and genetic factors that affect the route, magnitude, and duration of actual exposure.

Listed and described below are the various comparison values that ATSDR uses to select chemicals for further evaluation, as well as other non-ATSDR values that are sometimes used to put environmental concentrations into a meaningful frame of reference. Also listed below are the abbreviations for some of the more common units of measure.

CREG	=	Cancer Risk Evaluation Guides
MRL	=	Minimal Risk Level
EMEG	=	Environmental Media Evaluation Guides
IEMEG	=	Intermediate Environmental Media Evaluation Guides
RMEG	=	Reference Dose Media Evaluation Guide
RfD	=	Reference Dose
RfC	=	Reference Dose Concentration
RBC	=	Risk-Based Concentration
DWEL	=	Drinking Water Equivalent Level
LTHA	=	Drinking Water Lifetime Health Advisory
MCL	=	Maximum Contaminant Level

pMCL	=	Proposed Maximum Contaminant Level
PRG	=	Permissible Remediation Goal (Action Level)
PEL	=	Permissible Exposure Limit
SMCL	=	Secondary Maximum Contaminant Level
TLV	=	Threshold Limit Value
ppm	=	parts per million (mg/L water or mg/kg soil)
ppb	=	parts per billion (ug/L water or ug/kg soil)
kg	=	kilogram (1,000 grams)
mg	=	milligram (0.001 grams)
µg	=	microgram (0.000001 grams)
L	=	liter
m^3	=	cubic meter, referring to 1,000 liters of air)

Cancer Risk Evaluation Guides (CREGs) are estimated contaminant concentrations expected to cause no more than one excess cancer in a million persons exposed over a lifetime. CREGs are calculated from EPA's cancer slope factors or cancer potency factors using default values for exposure rates. However, neither CREGs nor CSFs can be used to make realistic predictions of cancer risk. The true risk is always unknown and may be as low as zero.

Minimal Risk Levels (MRL) are estimates of daily human exposure to a chemical (i.e., doses expressed in mg/kg/day) that are unlikely to be associated with any appreciable risk of deleterious noncancer effects over a specified duration of exposure. MRLs are calculated using data from human and animal studies and are reported for acute (≤ 14 days), intermediate (15-364 days), and chronic (≥ 365 days) exposures. MRLs are published in ATSDR Toxicological Profiles for specific chemicals.

Environmental Media Evaluation Guides (EMEGs) are concentrations that are calculated from ATSDR minimal risk levels by factoring in default body weights and ingestion rates. Chronic EMEGS are guidelines for exposures of greater than 365 days.

Intermediate Environmental Media Evaluation Guides (IEMEG) are calculated from ATSDR minimal risk levels; they factor in body weight and ingestion rates for intermediate exposures (i.e., those occurring for more than 14 days and less than 1 year).

Reference Dose Media Evaluation Guide (RMEG) is the concentration of a contaminant in air, water or soil that corresponds to EPA's RfD for that contaminant when default values for body weight and intake rates are taken into account.

Child Longer-Term Health Advisories (CLHA) are contaminant concentrations in water that the Environmental Protection Agency (EPA) deems protective of public health (taking into consideration the availability and economics of water treatment technology) over a lifetime (70 years), using a child's weight (10 Kg) and ingestion rate (1 L/day).

EPA's Reference Dose (RfD) is an estimate of the daily exposure to a contaminant unlikely to cause noncarcinogenic adverse health effects. Like ATSDR's MRL, EPA's RfD is a dose expressed in mg/kg/day.

Reference Concentrations (RfC) is a concentration of a substance in air which EPA considers unlikely to cause non-cancer adverse health effects over a lifetime of chronic exposure.

Risk-Based Concentrations (RBC) are media-specific concentrations derived by Region III of the Environmental Protection Agency Region III from RfDs, RfC's, or EPA's cancer slope factors. They represent concentrations of a contaminant in tap water, ambient air, fish, or soil (industrial or residential) that are considered unlikely to cause adverse health effects over a lifetime of chronic exposure.

Drinking Water Equivalent Levels (DWEL) are based on EPA's oral RfD and represent corresponding concentrations of a substance in drinking water that are estimated to have negligible deleterious effects in humans at an intake rate of 2 L/day for life, assuming that drinking water is the sole source of exposure.

Lifetime Health Advisories (LTHA) are calculated from the DWEL and represents the concentration of a substance in drinking water estimated to have negligible deleterious effects in humans over a lifetime of 70 years, assuming 2 L/day water consumption for a 70-kg adult, and taking into account other probable sources of exposure. In the absence of chemical-specific data, the assumed fraction of total intake from drinking water is 20%. Lifetime health advisories are not derived for compounds considered potentially carcinogenic for humans.

Maximum Contaminant Levels (MCLs) represent contaminant concentrations in drinking water that EPA deems protective of public health (considering the availability and economics of water treatment technology) over a lifetime (70 years) at an exposure rate of 2 liters of water per day.

Secondary Maximum Contaminant Levels (SMCL) are secondary drinking water standards that are unenforceable federal guidelines regarding taste, odor, color and certain other non-aesthetic effects of drinking water. EPA recommends them to the states as reasonable goals but federal law does not require water systems to comply with them.

Threshold Limit Value (TLV), according to the American Conference of Governmental Industrial Hygienists (ACGIH), is "the time-weighted average concentrations for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect". Many of ACGIH's TLVs were adopted by OSHA for use as PELs.

No Observed Adverse Effects Level (NOAEL), an exposure level in dose-response experiments, at which some effects are observed but where no statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control are observed.

Lowest Observed Adverse Effects Level (LOAEL), is the lowest exposure level in dose-response experiments at which statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control are observed. For a given study, the reported LOAEL will be specific for the type of effect under study, e.g., respiratory effects, neurological effects, etc.

Permissible Exposure Limits (PELs) are 8-hour, time-weighted average concentrations of contaminants in air developed for the workplace by the Occupational Safety and Health Administration (OSHA). This level may be exceeded for brief periods, but the sum of the exposure levels averaged over 8 hours must be equal to or below the PEL.

TLVs and PELs, which were designed to protect healthy workers, are usually much higher than the health-based values of ATSDR and EPA, which were designed to protect the health of the general population, including the very young and the elderly. ATSDR does not base any of its community health decisions solely or primarily on TLVs or PELs, but these and other non-ATSDR values may be referred to in Public Health Assessments or consultations as a means of providing the reader with an expanded, and perhaps more meaningful, perspective on the concentrations of contaminants detected at a site.

References

Agency for Toxic Substances and Disease Registry. Health Assessment Guidance Manual. Atlanta: ATSDR, March, 1992.