April 4, 2016 Addendum to the
Health Consultation
Evaluation of Private Drinking Water Well Samples
Coronet Industries
(a/k/a Borden Feed Phosphate Complex)
Plant City, Hillsborough County, Florida
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This report is an addendum to the above 2004 U.S. Agency for Toxic Substances and Disease Registry health consultation report [ATSDR 2004].

In 2003, the Florida Department of Environmental Protection (DEP) discovered contaminated ground water near the Coronet site in Plant City. Florida DEP provided bottled water or filters to the owners of nearby private drinking water wells. In 2004, the Florida Department of Health (DOH) prepared a health consultation report for the U.S. Agency for Toxic Substances and Disease Registry (ATSDR). Florida DOH and ATSDR concluded the highest boron level found in the 2003 testing did not increase the risk for non-cancer health effects. Florida DOH and ATSDR also concluded the highest radium levels did not increase the risk for cancer or non-cancer health effects [ATSDR 2004].

An inquiry by the U.S. Environmental Protection Agency (EPA) about the health risk from boron and radium in the above report prompted this addendum. Specifically, this addendum re-evaluates the health risk from drinking water from 15 wells that before 2003 had levels of boron or radium 226/228 above guidelines. Florida DOH now concludes:

- Infants, children, and adults who before 2003 drank from private wells near Coronet with the highest boron levels were not likely to suffer illness.

- Drinking and showering with water for 35 years before 2003 at the highest levels of radium 226/228 measured in 2003 may have caused, at most, a “low” to “very low” increased risk of cancer.

Site History

In 2003, Florida DEP and Florida DOH-Hillsborough tested 145 private drinking water wells near the Coronet hazardous waste site southeast of Plant City. They tested these wells in response to concerns of nearby residents about ground water contamination. Neither Florida DEP nor DOH-Hillsborough had tested these wells previously. Five wells had boron levels above the EPA child longer-term health advisory level (HAL) of 2 milligrams per liter (mg/L) and 14 wells had levels of radium 226/228 above the EPA drinking water standard of 5 picocuries per liter (pCi/L) (Table 1).

Florida DEP provided these well owners either bottled water or a reverse osmosis filter for the kitchen tap. After providing an alternative water source, Florida DEP did not resample these wells. Therefore, the 2004 Florida DOH/ATSDR assessment was limited to concentrations measured once in 2003. Between 2008 and 2010, Plant City extended municipal water lines and connected over 100 area homes. They did not, however, connect well AAG9926, used only for irrigation.

Boron

Boron occurs naturally in minerals, rocks, and soil. The richest boron-containing deposits in the U.S. are in the desert areas of southern California. Boron occurs naturally with oxygen to form borax, boric acid, boron oxide, etc.

Boron occurs naturally in plants and animals. It is an essential element for plant growth. Scientists believe that at least some boron in the diet is necessary for good health [EPA 2008].

Boron occurs naturally in the food we eat and the water we drink. Fruits, peas, beans, nuts, vegetables, and grains are rich in boron. Wine and avocado have especially high levels [WHO 2009]. The average level of boron in drinking water is between 0.005 and 0.700 milligrams per liter (mg/L) [EPA 2008].

On average, we eat and drink about 1.5 milligrams of boron a day (0.016 mg/kg/day) [EPA 2008]. About half of our intake is from food and half from water. There is no recommended daily allowance for boron because scientists have not identified an essential biological role.

The biggest use of boron is in glass making. Boron is also in many personal care products: shampoos, bath oils, face/bath powders, hair rinses, soaps, underarm deodorants, moisturizing creams, shaving lotions, dental hygiene products, and breath fresheners [EPA 2008]. Small amounts of boron are in plant foods, laundry detergents, fire retardants, leather tanning, pesticides, and high energy fuels [ATSDR 2010]. Coronet made potassium fluoroborate (KBF_4) for use in producing aluminum cans, foil, and other alloys.

The most sensitive health effect for adults ingesting boron appears to the reproductive system. Surveys of Turkish and Chinese populations with up to 25 mg/L boron in their drinking water (0.8 mg/kg/day), however, found no association between chronic-duration exposure and reproductive effects. In animal studies, decreased fetal weight gain is the most sensitive health effect for adults. To evaluate the toxicity of boron to adults, scientists estimate a benchmark boron dose of 59 mg/kg/day causes decreased fetal body weight in pregnant rats. They estimate the 95% lower confidence limit on this benchmark dose is 10.3 mg/kg/day ($BMDL_{05}$). This $BMDL_{05}$ is similar to the 9.6 mg/kg/day level that did <u>not</u> cause this effect in rats (no observed adverse effect level or NOAEL) [ATSDR 2010, EPA 2008].

The most sensitive health effect for children ingesting boron appears to be testicular toxicity. For evaluating the toxicity of boron to boys, scientists estimated a no observed adverse effect level (NOAEL) of 17.5 mg/kg/day for testicular toxicity in rats [ATSDR 2010, EPA 2008].

No evidence of cancer was found in a study in which mice were given boric acid in the diet throughout their lifetime. The National Toxicology Program, EPA, and the International Agency for Research on Cancer have not classified boron for human carcinogenicity [ATSDR 2010].

Table 2 lists dose estimates for the five wells with boron levels above EPA's child longer-term drinking water health advisory level (HAL) in 2003. Table 2 also compares these dose estimates to toxic levels in rats.

<u>Adults</u> – The highest boron levels in private drinking water wells near Coronet were not likely to cause non-cancer illness in adults. The highest level near Coronet (9.8 mg/L) was less than the

level that was not associated with reproductive problems in a study of Turkish and Chinese populations (25 mg/L). Table 2 shows that for an adult drinking well water near Coronet, the highest estimated dose (0.24 mg/kg/day) was 43 times less than the 95% lower confidence limit on the benchmark dose ($BMDL_{05}$) that caused decreased fetal weight in pregnant rats (10.3 mg/kg/day). The highest estimated dose was also 40 times less than the no observed adverse effect level (NOAEL) that did not cause decreased fetal weight gain in pregnant rats (9.6 mg/kg/day).

Infants and Children – The highest boron levels in drinking water wells near Coronet are not likely to cause non-cancer illness in infants or children. Table 2 shows that for a child drinking well water near Coronet, the highest estimated dose (0.54 mg/kg/day) is 32 times less than the highest dose that does not cause testicular toxicity in rats (17.5 mg/kg/day). In addition, the highest dose estimate for infants (0.3 mg/kg/day) is over 600 times less than the lowest dose known to cause nausea, persistent vomiting, diarrhea, and colicky abdominal pain (184 mg/kg/day) [ATSDR 2010].

Summary – Infants, children, and adults who before 2003 drank from private wells near Coronet with the highest boron levels were not likely to suffer illness.

Radium 226 and 228

Radium is a naturally occurring radioactive metal that exists in several forms called isotopes. Radium 226 and Radium 228 are two such isotopes. Radium results from the breakdown of two other radioactive elements: uranium and thorium. Radium occurs naturally at very low levels in soil, rocks, water, plants, and food. Because radium occurs naturally, a person is constantly exposed to it at low levels. Levels of radium in public drinking water are usually less than one picocurie per liter (pCi/L). One may be exposed to higher levels if one's drinking water is from a source naturally high in radium. Many counties in the western U.S., Maine, and New Hampshire, as well as some in central Florida have naturally occurring levels of radium in ground water above the drinking water standard of 5 pCi/L [ATSDR 1990].

Radium in water exists primarily as a divalent ion (Ra^{2+}) and has chemical properties similar to barium, calcium, and strontium. Although the solubility/mobility of radium in ground water depends on the type of aquifer material, the pH, and other ions present, in general radium is not mobile in ground water but is found near where it was deposited [ATSDR 1990].

Most swallowed radium (about 80%) will promptly leave the body in the feces. The other 20% will enter the blood stream and all parts of the body, especially the bones. The body excretes small amounts of this radium in the feces and urine on a daily basis. Radiation from the radium deposited in the bones can lead to an increased risk of bone cancer (sarcomas) [ATSDR 1990].

In determining the increased cancer risk from exposure to radium, both the level and the length of exposure are important. Based on EPA guidelines [EPA 1998], Florida DOH/ATSDR estimates the increased cancer risk from drinking and showering with radium contaminated water for 35 years (Table 1). Those 35 years include 28 years (1975 to 2003) of drinking and showering with the water and 7 years (2003-2010) of only showering with the water. (In 2003, owners of contaminated wells began drinking bottled or filtered water and by 2010, they had connected to the municipal supply.) Using water from the Coronet area well with the highest radium level (29.6 pCi/L) for 35 years would have resulted in a "low" increased lifetime cancer risk of approximately 1 in 10,000 or 1×10^{-4}. In contrast, the increased risk from using water at

the lowest level for 35 years (5.7 pCi/L) would have resulted in a “very low” increased lifetime cancer risk of approximately 3 in 100,000 or 3 x 10^{-5}.

To put this increased cancer risk into context; the American Cancer Society estimates that one out of every three Americans (or 3,333 in 10,000) will be diagnosed with some form of cancer in their lifetime. Adding the estimate of the “low” increased cancer risk from 35 years exposure to the highest level of radium 226/228 found in a Coronet area drinking water well would have, at most, increased the cancer incidence from 3,333 in 10,000 to 3,334 in 10,000.

Summary - Using radium contaminated private well water from the Coronet area for 35 years would have resulted in a “low” to “very low” increased lifetime cancer risk.

Florida DOH will explain the risk to the owners of the 15 private wells that in 2003 had boron or radium 226/228 levels above guidelines.

References

[ATSDR 1990] Agency for Toxic Substances and Disease Registry. Toxicological Profile for Radium. U.S. Department of Health and Human Services. TP-90-22. December 1990.

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[EPA 1998] Environmental Protection Agency. Federal Guidance. Report No. 13-Part1. Interim Version. Health Risks from Low-Level Environmental Exposures to Radionuclides.

[EPA 2008] Environmental Protection Agency. Drinking Water Health Advisory for Boron. Document Number: 822-R-08-013. Health and Ecological Criteria Division, Office of Science and Technology, Office of Water. Washington, DC 20460. May, 2008.

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Table 1. 2003 Coronet Area Private Drinking Water Wells with Boron and Radium 226/228 Levels above Guidelines

Well Number (FLUWID)	Boron Level (mg/L)	Boron Child Longer-term HAL* (mg/L)	Radium 226/228 Level (pCi/L)	Radium 226/228 Drinking Water Standard* (pCi/L)	Increased Cancer Risk from 35 Years Exposure to Radium 226/228
AAH9757	9.8	2	27.2	5	1×10^{-4}
AAH9756	8.7	2	29.6	5	1×10^{-4}
AAG9929	4.0	2	19.0	5	9×10^{-5}
AAG9928	3.8	2	18.1	5	9×10^{-5}
AAH9763	2.5	2	1.8	5	---
AAG9964	1.1	2	8.2	5	4×10^{-5}
AAH9764	0.35	2	7.9	5	4×10^{-5}
AAG9941	0.25	2	5.9	5	3×10^{-5}
AAG9965	0.057	2	7.4	5	4×10^{-5}
AAH9752	0.043	2	9.0	5	4×10^{-5}
AAG9945	BDL	2	5.7	5	3×10^{-5}
AAG9946	BDL	2	8.1	5	4×10^{-5}
AAG9927	BDL	2	12.4	5	6×10^{-5}
AAG9926	---	---	5.9	5	3×10^{-5}
AAH9754	---	---	7.0	5	3×10^{-5}

FLUWID = Florida unique well identification mg/L = milligrams per liter pCi/L = picocuries per liter BDL = below detection limit
HAL = health advisory level
Levels above drinking water health advisory level (Boron = 2 mg/L) or drinking water standard (Radium 226/228 = 5 pCi/L)
* HALs and drinking water standards used to screen test results, not for determining the risk of illness. Water levels above the HAL or drinking water standard don't necessarily cause illness.

Table 2. 2003 Coronet Area Drinking Water Well Boron Levels, Drinking Water Doses, Guidelines, and Toxic Levels

Drinking Water Well Boron Levels (mg/L)	Infant Boron Drinking Water Dose (mg/kg/day)	Child Boron Drinking Water Dose (mg/kg/day)	Adult Boron Drinking Water Dose (mg/kg/day)	Boron Acute & Intermediate Oral MRLs* (mg/kg/day)	Lowest Boron Dose Causing Decreased Fetal Weight in Rats** (mg/kg/day)	Highest Boron Dose Not Causing Testicular Toxicity in Rats*** (mg/kg/day)
9.8	0.30	0.54	0.24	0.2	10.3	17.5
8.7	0.27	0.48	0.21	0.2	10.3	17.5
4.0	0.12	0.22	0.10	0.2	10.3	17.5
3.8	0.12	0.21	0.09	0.2	10.3	17.5
2.5	0.08	0.14	0.06	0.2	10.3	17.5

mg/L = milligrams per liter mg/kg/day = milligrams per kilogram per day
MRL = ATSDR minimal risk level
Dose exceeds ATSDR acute/intermediate MRL of 0.2 mg/kg/day
* MRLs are for screening, not for determining the risk of illness. Doses greater than the MRL do not necessarily cause illness.
** 95% lower bound on the bench mark dose ($BMDL_{05}$)
*** No observed adverse effect level (NOAEL)

REPORT PREPARATION

The Florida Department of Health (DOH) prepared this addendum with funding from, and under a cooperative agreement with, the Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Department of Health and Human Services (DHHS). Florida DOH prepared this addendum using ATSDR guidelines. ATSDR does not, however, certify that this addendum conforms to its standards. The findings and conclusions of this addendum are therefore those of Florida DOH and do not necessarily represent the views of ATSDR or DHHS.

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Appendix A

Boron Exposure Estimate

For exposure to boron in private drinking water wells near the Coronet site in 2003, Florida DOH/ATSDR calculated an exposure factor for an infant, child, and adult based upon the following formula.

$$EF = (F \times ED) / AT$$

where EF = exposure factor, F = frequency (350 days per year), ED = exposure duration (years): adult =35; child= 6; infant =2), and AT = averaging time (ED x 365 days per year)

Florida DOH used this exposure factor in estimating a dose from drinking water.

$$D = (C \times IR \times EF) / BW$$

where D = exposure dose (mg/kg/day)
C = contaminant level (mg/L)
IR = intake rate of contaminated water (L/day): adult = 2, child = 1, infant 0.25
EF = exposure factor (unitless)
BW = body weight (kg): adult = 80, child = 17.4, infant = 7.8

The highest boron concentration in a private drinking water well near Coronet in 2003 was 9.8 mg/L. (The 2004 health consultation report erroneously reported the highest boron concentration was 17 mg/L.) For an adult drinking water with the highest boron level for 35 years, the dose is:

$$D = (9.8 \text{ mg/L} \times 2 \text{ L/day} \times 0.96) / 80 \text{ kg} = 0.24 \text{ mg/kg/day}$$

For a child drinking water with the highest boron level for 6 years, the dose is:

$$D = (9.8 \text{ mg/L} \times 1 \text{ L/day} \times 0.96) / 17.4 \text{ kg} = 0.54 \text{ mg/kg/day}$$