Letter Health Consultation

ELIZABETH MINE SUPERFUND SITE

TOWN OF STRAFFORD, VERMONT

EPA FACILITY ID: VT988366621

MARCH 17, 2014

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

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 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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LETTER HEALTH CONSULTATION

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Prepared By

Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Eastern Branch

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March 17, 2014

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Subj: Private Drinking Water Well at Elizabeth Mine, in the Town of Strafford, Vermont

EPA Site ID: VTD988366621

EPA Region I requested that ATSDR review the 2013 environmental data collected at a private well adjacent to the Elizabeth Mine Superfund Site to determine whether the well water is safe to use as drinking water. This private well has been tested since 2001 in support of the EPA remedial investigation and feasibility study but the manganese levels were inconsistent until 2010 when high levels of manganese were detected. At that time, EPA informed the family not to drink the water. In 2013, the well was again tested in a more systematic manner to better characterize the elevation in contaminants. Our conclusions apply now or in the future if the well water is used for consumption.

The well water was tested numerous times in 2013. Manganese and cobalt were present at levels above ATSDR's screening values for drinking water, thus requiring a more thorough toxicological evaluation to determine whether harmful effects might be possible. The highest concentration of manganese and cobalt in the well water was 2,990 µg/liter and 119 µg/liter, respectively. Children and adults consuming the well water at this manganese concentration could experience health effects such as severe neurological impairments. Therefore, it is not safe to drink or cook with water from this well. It is uncertain whether the estimated doses for children drinking the water at this cobalt concentration will result in harmful effects. Since exposure to the manganese contamination in the well water is the primary reason for concern, protecting children and adults from excessive manganese exposure will also protect them from possible concerns related to cobalt.

Background:

The Elizabeth Mine Superfund Site is an abandoned copper mine located on Mine Road in the Village of South Strafford within the Town of Strafford, Orange County, Vermont. The Elizabeth Mine site is located in a rural setting, on the east side of Copperas Hill. The property consists of three mine tailings piles, two open-cut mines, several horizontal mine entrances, underground shafts and tunnels, ventilation shafts, and several former ore processing buildings.

The tailings on the property are rich in metals and sulfides. As water passes over and through the tailings, sulfuric acid is produced and the metals within the tailings are dissolved and mobilized. This results in acid mine drainage. Acid mine drainage contributes an elevated load of metals to Copperas Brook and the West Branch Ompompanoosuc River. The Elizabeth Mine has been previously investigated by State and Federal agencies, and by private companies. As part of the various studies, one or more samples of mine tailings, surface water, sediment, fish tissues, ground water, and one drinking water well have been collected and analyzed for metals. The results indicated the presence of metals that exceeded background levels.

In 2004, ATSDR released a Public Health Assessment (PHA) for the site. In the PHA ATSDR determined that no harmful exposures currently existed at the Elizabeth Mine site. ATSDR, therefore, classified exposures at the Elizabeth Mine site as posing no apparent public health hazard. In 2006, EPA tested private wells in the area and no elevation in contaminants was detected. In 2010, EPA retested this well, and after finding some elevation in contaminant levels recommended the family use bottled water for cooking and drinking.

In 2013, as part of ongoing work at the site and the 5 year review process, EPA collected well samples from this and other properties around the site. EPA identified this one well as having elevated concentrations of manganese and cobalt. The Remedial Project Manager for the site requested ATSDR to look at the well sampling data collected from May to October 2013. It is not possible for ATSDR to estimate exposures, between 2006 and 2010, because of the uncertainty of who lived at the residence and for what period of time they lived at the residence. In addition, variability of contaminant concentrations existed between this time period.

Discussion:

Manganese

ATSDR was provided drinking water data from May, June, July, August, September, and October 2013. Manganese concentrations have generally been trending up over the sampling period provided and ranged from 1,910 to 2,990 µg/liter. Concentrations of dissolved manganese in the private well were 2,990 µg/liter in the most recent sample collected on October 21, 2013. We used this concentration for determining possible health effects from consumption of the water.

ATSDR's comparison values for manganese are based on EPA's water RfD for manganese of 50 µg/kg/day. The comparison values, referred to as reference dose media evaluation guides (RMEGs), are 500 µg/liter for children and 1,800 µg/liter for adults[1]. Because the manganese concentration in the private well near the Elizabeth Mine Site exceeds these comparison values, manganese will be evaluated further by first estimating the site-specific dose of manganese for children and adults.

Estimated manganese doses from drinking water were calculated for an infant, a 30 kg child, and an adult. The estimated exposure doses for an infant and child were based on a 1 liter per day ingestion rate for a 10 kg and 30 kg body weight, respectively. The estimated exposure dose for an adult was based on 3 liters per day ingestion rate for an 80 kg body weight. Estimated

[1] Agency for Toxic Substances and Disease Registry, "Toxicological Profile for Manganese," September 2012.

manganese doses in children ranged from 100 to 300 µg/kg/day and the estimated dose in adults was 112 µg/kg/day. Manganese dissolved in water was assumed to have a bioavilability of 100% and this is the same assumption that was used to develop EPA's RfD[1].

Several human studies evaluate the risk of harmful effects from exposure to manganese via drinking water. Most human studies compare the risk of harmful effects with manganese levels in drinking water; only a few human studies report the dose of manganese in µg/kg/day. Therefore, we will evaluate the potential for health risks based on manganese levels cited in these studies.

In a study of adults over age 50 years, Kondakis, *et al.*[2] reported an association with the increase of manganese concentrations in drinking water and a higher prevalence of neurological signs of chronic manganese poisoning. Weakness, fatigue, gait disturbances, and tremors were some of the signs and symptoms documented. The authors compared the drinking water concentrations for three geographical areas in Greece; the range of manganese concentrations in these three areas was 4 to 15 µg/liter, 82 to 253 µg/liter, and 1,800 to 2,300 µg/liter. The highest exposure group (1,800 to 2,300 µg/liter), which showed the greatest impact for neurological effects, is similar to the manganese levels in the private well near the Elizabeth Mine Site (1,910 to 2,990 µg/liter). The authors did not report estimated doses for the populations studied because of uncertainty in the amount of groundwater that participants drank. Nevertheless, it is reasonable to assume that adults who drink water from the private well near the Elizabeth Mine Site could experience harmful neurological effects involving weakness, fatigue, gait disturbances, and tremors.

Several studies investigate manganese exposure and harmful effects in children. In a study of 6 to 13 year old children, Bouchard, *et al*.[3] found an association between groundwater manganese levels and intellectual impairment in children. The median manganese concentration in children's home tap water was 34 µg/L (range, 1–2,700 µg/liter). Higher manganese water concentrations were significantly associated with lower IQ scores. The authors reported a 6 point difference in IQ scores for children in the lowest exposure group (median manganese 1 µg/liter) and children in the highest exposure group (median manganese 216 µg/liter). Manganese water levels were more strongly associated with performance rather than verbal IQ.

Several case reports are available about children exposed to manganese from using private wells with elevated manganese levels. Brna *et al*.[4] reported a case study of a 5-year old girl with significant behavioral changes, including decreased speech, repetition of another person's words, finger sucking and licking, and withdrawn behavior. Neurologic symptoms included problems with coordination, including falls, an inability to write her name, and difficulty dressing. The authors confirmed manganese exposure through elevated blood and serum manganese levels and identified the source as a private well contaminated with manganese (1,200 µg/liter). Located at a second home, the private well was used during the summer for several years until the problem was identified. Estimated doses were not provided in the journal article.

[2] Kondakis, X.G., N. Makris, M. Leotsinidis, M. Prinou and T. Papapetropoulos. 1989. Possible health effects of high manganese concentration in drinking water. Arch. Environ. Health. 44(3): 175-178.
[3] Bouchard MF, Sauve S, Barbeau B, *et al.* 2011. Intellectual impairment in school-age children exposed to manganese from drinking water. Environ Health Perspect 119(1):138-143.
[4] Brna P, Gordon K, Dooley JM, *et al.* 2011. Manganese toxicity in a child with iron deficiency and polycythemia. J Child Neurol 26(7):891-894.

Woolf *et al.*[5] [2002] reported a case study of a 10-year old child exposed for five years from using a private well contaminated with manganese at 1,200 µg/liter. The child was evaluated when teachers noticed inattentiveness and a lack of focus in the classroom. A medical evaluation showed problems with verbal and visual memory. The estimated daily dose was 60 µg/kg/day [ATSDR 2012].

Wasserman *et al.*[6] evaluated intellectual function in 142 children (age 10 years) where average drinking water manganese levels was 793 µg/liter. The authors reported that compared to the lowest exposure group higher water manganese levels was associated in a dose response fashion with reduced full-scale, performance, and verbal scores for intelligence. Children were grouped into four exposure levels (< 200 µg/liter; 200 to 499 µg/liter; 500 to 999 µg/liter; and ≥ 1,000 µg/liter. Daily estimated manganese intakes were 230, 995, 1,800, and 4,045 µg/day, which equates to daily doses of 8, 35, 62, and 140 µg/kg/day. The estimated dose for children (100 and 299 µg/kg/day) at the Elizabeth Mine site falls into the upper exposure levels in the Wasserman study.

Based on our estimated exposure doses and reports from these studies, children who drank water from the private well near the Elizabeth Mine Site containing 1,910 to 2,990 µg/liter of manganese would be at risk of harmful effects involving the neurological and developmental systems. Possible harmful effects include not reaching their IQ potential, problems with memory, and problems with coordination.

Cobalt

The sample results also included the full range of metals and the only other analyte that was elevated was cobalt ranging from 75.2 to 119 µg/liter. Cobalt was slightly above ATSDR's comparison value of 100 µg/liter for children. The maximum, worst-case, estimated dose is for an infant child (16.9 µg/kg/day) and is slightly greater than ATSDR's Intermediate Minimal Risk Level (MRL) of 10 µg/kg/day[7], but about 60 times below the less serious LOAEL of 1,000 µg/mg/day from the study. However, the study the MRL is based on evaluated exposure to cobalt chloride[8].

The contaminated well has cobalt as cobalt sulfate and the study by Morin, *et al.*, 1971[9], implies that the sulfate form is more potent than the chloride and reported a serious human LOAEL of 40 µg/kg/day. However, the Morin study was heavily confounded by the fact that it was studying men who drank on average 24 pints of beer per day. Therefore, it is not clear that the cobalt concentrations from the well would result in an increased health risk to children. Since exposure to the manganese contamination in the well water is the primary reason for concern, protecting children and adults from excessive manganese exposure will also protect them from possible concerns related to cobalt.

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[5] Woolf A, Wright R, Amarasiriwardena C, *et al.* 2002. A child with chronic manganese exposure from drinking water. Environ Health Perspect 110:613-616.
[6] Wasserman GA, Liu X, Parvez F, *et al.* 2006. Water manganese exposure and children's intellectual function in Araihazar, Bangladesh. Environ Health Perspect 114(1):124-129.
[7] Agency for Toxic Substances and Disease Registry, "Toxicological Profile for Cobalt," April 2004.
[8] Davis, J.E. and Fields, J.P. 1958. Experimental production of polycythemia in humans by administration of cobalt chloride. Proc Soc Exp Biol Med 99:493-495.
[9] Morin Y, Tetu A, Mercier G. 1971. Cobalt cardiomyopathy: Clinical Aspects. Br Heart J 33:175-178.

Conclusions:

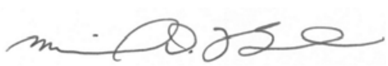
1. ATSDR concludes that harmful health effects in children and adults are possible from consumption of well water.
2. Other private wells in the area have not been adversely impacted by the site, because concentrations of metals are below health based screening values.

Recommendations:

1. Do not use water from the well for drinking, cooking or other consumptive purposes.
2. Ensure that the residents at this location are on an alternate source of potable water.
3. Inform the residents of these findings and provide appropriate assistance to address any health concerns.
4. Continue monitoring the wells to ensure the wells are safe.

Please do not hesitate to contact me at 617-918-1490 or mdb7@cdc.gov, if you have any questions regarding this letter.

Sincerely,



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