

Letter Health Consultation

WELL RWA-97 2014 TEST RESULTS EVALUATION

OFF-SITE OAK RIDGE RESERVATION

OAK RIDGE, ROANE COUNTY, TENNESSEE

MARCH 4, 2016

Preparation of this report was supported by funds from a Cooperative Agreement with the Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services.

This document was prepared by the Tennessee Department of Health's Environmental Epidemiology Program. This document has not been formally reviewed and cleared by ATSDR.

March 4, 2016

Mr. Eddie Worthington, Geologist
Tennessee Department of Environment and Conservation
Department of Energy Oversight Office – Oak Ridge Reservation
761 Emory Valley Road
Oak Ridge, TN 37830

RE: Letter Health Consultation - Well RWA-97 2014 Test Results Evaluation, Off-site Oak Ridge Reservation, Tennessee

This letter health consultation is based on our conference call of Monday, February 29, 2016. You requested the Tennessee Department of Health's (TDH) Environmental Epidemiology Program (EEP) evaluate whether levels of lithium, fluoride, and lead in water samples collected during 2014 from a residential well designated RWA-97 would pose a health concern. Levels of these three substances were measured above levels of commonly used health screening values. The RWA-97 well was sampled in March, June, and October 2014. EEP reviewed all 2014 data from the well. Samples collected in March and June 2014 were collected before the home filter treatment system. The October 2014 samples were collected both before and after the home filter treatment system.

It is our understanding that the levels of lithium ranged from 4.3 micrograms per liter ($\mu\text{g/L}$) to 53 $\mu\text{g/L}$. Fluoride levels for the three sampling events ranged from an estimated value of 0.058 $\mu\text{g/L}$ to 1,200 $\mu\text{g/L}$. Lead levels ranged from non-detect ($<0.51 \mu\text{g/L}$) to 3.8 $\mu\text{g/L}$. Neither the Tennessee Department of Environmental and Conservation (TDEC) Department of Energy Oversight (DOE-O) Office or EEP know if these levels are naturally-occurring or are from activities or releases related to the nearby Oak Ridge Reservation.

Further, EEP understands a filtering system is in place that filters all uses of the water such as drinking, cooking, and bathing.

EEP first reviewed health comparison values established by the Agency for Toxic Substances and Disease Registry (ATSDR) and the U.S. Environmental Protection Agency (EPA). ATSDR does not have specific health comparison values for lithium or lead but does have a Minimal Risk Level (MRL) for fluoride (ATSDR 2015b). EPA has developed Regional Screening Levels (RSLs) used to determine whether levels of chemicals found at a site may warrant further investigation or cleanup, or whether no further investigation or action is required.

If a sampling result is above a comparison value, such as those provided by ATSDR or EPA, it does not necessarily mean there would be harmful effects from drinking, breathing, or coming into contact with the substance. It means the exposure someone may have to the substance should be evaluated further (ATSDR 2005).

Initial Evaluation of Results

Since ATSDR does not have screening levels for these substances, EEP screened the well sampling results against EPA RSLs to understand if these levels needed further evaluation. Three unfiltered lithium sampling results ranging from 47 to 53 µg/L were above its EPA RSL of 40 µg/L. The average of these three results was 51 µg/L. The filtered lithium sample and its duplicate sample results were 4.3 µg/L and 4.4 µg/L respectively. These results were below the RSL. For fluoride, the three unfiltered sample results ranged from 1,100 to 1,200 µg/L, with an average of 1,167 µg/L. All three results were above its EPA RSL of 800 µg/L. The filtered sample result and its duplicate result were 0.058 µg/L and 0.053 µg/L, respectively. These levels were below the fluoride RSL. All results for lead from the well were below its Maximum Contaminant Levels (MCL) "action level" of 15 µg/L. However, the Maximum Contaminant Level Goal (MCLG) for lead is zero, and the duplicate sample collected after the filter system had a level of 3.8 µg/L, which was above the MCLG.

Lithium

An evaluation of lithium is discussed here. There is ample evidence that lithium at low levels causes no serious adverse health effects. Because lithium is routinely used as a drug for the treatment of clinical depression, there is a large body of data on the human health effects of lithium exposure.

ATSDR does not have a health comparison value for lithium. EPA has an RSL of 40 µg/L. ATSDR has developed a dose that is considered the Lowest Observed Adverse Effect Level (LOAEL) for lithium of 2.1 milligrams per kilogram per day (mg/kg/day). The LOAEL is the lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals. A provisional Reference Dose (RfD) was calculated by EPA (2008) to be 2.0E-3 by using the LOAEL and dividing it by an uncertainty factor of 1,000. This RfD is an EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

To understand if there could be potential harmful health effects from lithium levels in water from well RWA-97, estimated doses were calculated for an infant, a child, and an adult to allow for comparison to the provisional RfD and LOAEL. A dose calculation was done for, an infant, a child over an age range from 1 to 21 years, and an adult drinking the average level of lithium measured in the well during the 2014 sampling events. The ingestion rates, body weights, and exposure frequencies in Table 1 were used to calculate an exposure dose.

Table 1. Parameters used to estimate an exposure dose.		
Age Range (years)	Water Ingestion Rate 95th percentile (milliliters/day)	Body Weight (kilograms)
Infant (Birth to <1 year)	1,113	7.8
Child (1 to <2 years)	893	11.4
(2 to <6 years)	1,052	17.4
(6 to <11 years)	1251	31.8
(11 to <16 years)	1,744	56.8
(16 to <21 years)	2,340	71.6
Adult (21 to <65 years)	2,848	80

Note: EPA Exposure factor Handbook, 2011
 Exposure Frequency = 1 for an infant and adult. Variable for a child depending on age range.

The following general equation is used to calculate the chronic (1 year annual) exposure dose:

$$D = \frac{C \times IR \times EF \times AF}{BW}$$

Where:

- D = Exposure dose in milligrams/kilogram/day (mg/kg/day)
- C = Highest concentration of chemical (in milligrams per liter – mg/L)
- IR = Intake rate (liters/day – L/day)
- EF = Exposure frequency, exposure events per year of exposure (unitless)
- AF = Absorbtion factor (bioavailability factor) (unitless) – assumed to be 100% or 1
- BW = Body weight (in kilograms – kg)

Off-site lithium levels found in wells in the Melton and Bethel Valleys are also discussed in ATSDR’s 2015 Health Consultation (ATSDR 2015a). Lithium levels found in the Melton and Bethel Valleys were higher than those found in well RWA-97. The Health Consultation states that wells had levels ranging from 186 µg/L to 3,584 µg/L. The highest level found in the three 2014 samples collected from this well, as stated earlier, was 53 µg/L. An average level for the three sampling events of 51 µg/L was used to estimate the dose from the unfiltered water for the residents.

Estimated theoretical Reasonable Maximum Exposure (RME) doses calculated for drinking unfiltered water for 1 year from this well were calculated to be 7.3 E-3 mg/kg/day for an infant and 1.8E-3 mg/kg/day for an adult. For a child over the age range of 1 year to less than 21 years of age the RME was 4.2E-2 mg/kg/day. These doses are tabulated in Table 2. The RME doses for filtered water, based on the October 2014 sampling results are 6.3E-4 for an infant, 3.7E-3 for a child, and 1.6E-4 for an adult. These doses are also shown in Table 2.

Maximum Concentration (micrograms/liter - µg/L)	Estimated exposure dose (milligrams/kilogram/day)		
	Infant	Child	Adult
Before filter – average 51 µg/L	0.0073	0.042	0.0018
After filter – average 4.4 µg/L	0.00063	0.0037	0.00016
EPA provisional RfD	0.002 mg/kg/day		
Lowest Observed Adverse Effects Level (LOAEL)	2.1 mg/kg/day		

Both the child and infant estimated theoretical exposure doses were found to be above the provisional chronic RfD for the before filter sample result. The adult estimated dose was approximately the same as the provisional RfD. However, estimated doses for an infant, child, and adult were below the LOAEL.

For the October 2014 lithium level after the filter, calculated theoretical exposure doses for a child (1 year to less than 21 years) were estimated to be slightly higher than the provisional RfD, but lower than the LOAEL. The infant and adult estimated doses for water after the filter were found to be lower than both the RfD and the LOAEL.

Based on the evaluation, drinking water from well RWA-97 having the measured levels of lithium is not expected to cause harmful health effects.

One potential issue could be if a child or an adult drinking water from this well is taking prescribed lithium medication for bi-polar disorder. One can refer to ATSDR's March 4, 2015 Health Consultation: *U.S. Department of Energy Oak Ridge Reservation: Off-Site Groundwater in Melton Valley and Bethel Valley, Tennessee, Oak Ridge, Anderson County, Tennessee* for a more thorough discussion on this topic.

Fluoride

Many communities fluoridate their public drinking water supplies. The recommended fluoride level is about 700 µg/L. In the U.S., approximately 15,000 water systems serving 162 million persons are fluoridated in the optimal range of 700 to 1,200 µg/L, either occurring naturally or through adjustment (ATSDR 2015a).

Off-site fluoride levels in the Melton and Bethel Valleys were also discussed in ATSDR's 2015 Health Consultation (ATSDR 2015). Fluoride levels found in the Melton and Bethel Valleys were higher than those found in well RWA-97. RWA-97 is also specifically mentioned in ATSDR's March 5, 2015, Health Consultation. The Health Consultation stated that well RWA-97 was used for home purposes and that ten groundwater samples collected from the well had levels ranging from 1,300 µg/L to 1,450 µg/L, with a mean concentration of 1,350 µg/L. The highest level found in the three unfiltered 2014 samples collected from this well was 1,200 µg/L, with an average of 1,167 µg/L.

ATSDR has a health comparison value (MRL) for fluoride of 0.05 mg/kg/day (ATSDR 2015b). This MRL is used to evaluate long-term ingestion. EPA has a RSL of 800 µg/L. ATSDR does have a No Observed Adverse Effects Level (NOAEL) for fluoride of 1.5E-1 mg/kg/day and a LOAEL of 2.5E-1 mg/kg/day. A NOAEL is the highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

Estimated exposure doses using the average fluoride level found in the well in 2014 of 1,167 µg/L are shown in Table 3. Both unfiltered and filtered concentrations were used in the calculations. If the residents drink unfiltered water the calculated theoretical exposure dose would be above the MRL and the NOAEL for both the infant and child residents. Infant, child, and adult residents of the home drinking water after the filter would have calculated theoretical exposure doses below the MRL, NOAEL, and LOAEL.

Table 3. Estimated theoretical exposure doses for fluoride for Well RWA-97			
Maximum Concentration (micrograms/liter - µg/L)	Estimated exposure dose (milligrams/kilogram/day)		
	Infant	Child	Adult
Before filter—average 1,167 µg/L	0.17	1.0	0.042
After filter—average 0.056 µg/L	0.008	0.047	0.002
ATSDR MRL	0.05 mg/kg/day		
Estimated No Observed Adverse Effects Level (NOAEL)	0.15 mg/kg/day		
Lowest Observed Adverse Effects Level (LOAEL)	0.25 mg/kg/day		

The filtered water fluoride level from this well is low compared to typical fluoride levels in municipal water. The residents should consider continuing to use fluoridated toothpaste and other mouth hygiene products containing fluoride to have the benefit that this element provides while utilizing their water filter and treatment system.

Drinking water before the filter on the well could potentially be harmful to infants and children. If the levels were to increase over time, they could potentially cause dental fluorosis. However, based on the evaluation, drinking water after the filter from well RWA-97 having the measured levels of fluoride is not expected to cause harmful health effects.

Lead

For all three 2014 before filter sampling results the lead level was less than the laboratory detection limits for the metal: <0.51 µg/L for March 2014 and <0.064 µg/L for both June and October 2014. The sample collected after the filter in October 2014 was also non-detect, being lower than the detection limit of 0.64 µg/L. However, the duplicate sample collected after the filter had a measured lead level of 3.8 µg/L. It is unknown why the duplicate sample collected after the filter had a detectible level of lead.

The EPA has an "action Level" MCL for lead of 15 µg/L. EPA has a MCLG of 0 µg/L.

According to personnel in your office, lead levels above test detection limits have been measured in previous sampling event results from well RWA-97. For the evaluation of the 2014 results, EEP used the detection limit from the original filtered sample (0.64 µg/L) and added it to the measurement of the duplicate filtered sample (3.8 µg/L) to obtain an average lead level of 2.2 µg/L.

For comparison, in ATSDR's March 5, 2015 Health Consultation, an upper mean lead level of 2.9 µg/L from wells sampled in the Melton and Bethel Valleys was used along with a 100 milligrams per kilogram lead in soil level and other default parameters to calculate a mean blood lead level using the integrated exposure uptake biokinetic model. The calculated blood lead level from the model for this scenario was 1.7 micrograms per deciliter (µg/dL) for an exposure timeframe of 84 months (7 years). The calculated blood lead level is less than the 5 µg/dL blood lead level the model predicts 99% of the exposed population would have. Therefore, using the average lead level from the RWA-97 well of 2.2 µg/L, a blood lead level lower than 1.7 µg/dL would be expected for anyone drinking water from the well during 2014.

Based on the 2014 test results for lead from well RWA-97, it is not expected that drinking filtered water from the well would cause harmful health effects.

Conclusion

EEP evaluated detectible levels of chemicals in well RWA-97. Based on the 2014 sampling results the lithium levels in the well are above an EPA provisional RfD dose but much lower than the level where the first health effects have been noted. Calculated theoretical fluoride dose levels in the unfiltered well water are above or equal to its MRL and no effects level for an infant and child. For the filtered well water fluoride results, the calculated theoretical dose levels for an infant, child, and adult are all below its MRL and the no effects and lowest effects levels. For lead, the unfiltered 2014 water samples are non-detect, with detection limits less than 1 µg/L. The filtered sample was non-detect but its duplicate filtered sample was below the lead MCL but above a MCLG. **Estimated theoretical doses for lithium and fluoride in well RWA-97 unfiltered water are above some health effects levels for an infant and/or a child. Overall, drinking filtered water from well RWA-97 should not cause harmful health effects.**

Recommendations

The results from sampling RWA-97 during 2014 are all a “snapshot at the time” of the quality of the water the well intercepts and is used by the residents of the home. It is not possible to know what the quality of the water in the well is at all times. It has been two years since this well has been sampled. The water quality may have changed since the last sampling event. Given the measured levels of lithium, fluoride, and lead in the unfiltered well water, EEP recommends that the residents continue to maintain their filtering system and not drink water straight from the well without any type of treatment. If municipal water becomes available to the residents they should consider connecting to prevent future questions about the quality of their well water and to provide their family water with a measured quality, as required by TDEC and EPA.

EEP is available to evaluate more recent RWA-97 well test results should they become available. If you have other questions, please don't hesitate to call me at 615-741-7247.

Respectfully,



Joseph George
Environmental Health Assessor

References

[ATSDR] Agency for Toxic Substances and Disease Registry. 2005. Public Health Assessment Guidance Manual (Update). U.S. Department of Health and Human Services. Public Health Service. Agency for Toxic Substances and Disease Registry. Atlanta GA. January 2005.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2015a. Minimal Risk Levels. U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry. Division of Community Health Investigations. Atlanta GA. October 2015.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2015b. Health Consultation for the U.S. Department of Energy Oak Ridge Reservation, Off-Site Groundwater in Melton Valley and Bethel Valley, Tennessee, Oak Ridge, Anderson County, Tennessee, EPA Facility ID: TN1890090003. U.S. Department of Health and Human Services, Division of Community Health Investigations. Atlanta GA. March 5, 2015.

[USEPA] US Environmental Protection Agency. 2008. Provisional Peer Reviewed Toxicity Values for Lithium (CASRN 7439-93-2). Cincinnati: Superfund Health Risk Technical Support Center. June.

[USEPA] US Environmental Protection Agency. 2011. Exposure factor handbook: 2011 Final. Washington DC. National Center for Environmental Assessment, USEPA/600/R-09/052F

REPORT PREPARATION

This Letter Health Consultation for the Well RWA-97 Test Results Evaluation, Off-Site Oak Ridge Reservation, Oak Ridge, Roane County, Tennessee, was prepared by the Tennessee Department of Health's Environmental Epidemiology Program. Preparation of this report was supported by funds from a Cooperative Agreement with the Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services. It is in accordance with the approved agency methods, policies, and procedures existing at the date of publication.

This document has not been formally reviewed and cleared by ATSDR.

Author

Joseph P. George, PG, MS
Environmental Health Assessor, Environmental Epidemiology Program
Tennessee Department of Health

State Reviewers

David M. Borowski, MS
Assistant Director, Environmental Epidemiology Program
Tennessee Department of Health

Craig A. Shepherd, MPH, REHS/RS, DAAS
Director, Environmental Epidemiology Program
Tennessee Department of Health

Certification

This Health Consultation: *Well RWA-97 Well 2014 Test Results Evaluation, Off-Site Oak Ridge Reservation, Oak Ridge, Roane County, Tennessee*, was prepared by the Tennessee Department of Health's Environmental Epidemiology Program. It was prepared in accordance with the approved methodology and procedures that existed at the time the health consultation was prepared.

A handwritten signature in black ink, reading "Craig L. Appel", is positioned above a solid horizontal line.

Director, Environmental Epidemiology Program
Tennessee Department of Health