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Final Results of the North Pole Garden Sampling Project

Introduction

Sulfolane is a man-made chemical that is commonly used as a solvent during the oil and gas refining process. The U.S. Environmental Protection Agency does not regulate sulfolane levels in drinking water. In October 2009, sulfolane was detected in many private wells in the North Pole area. The health effects of sulfolane are poorly understood due to a shortage of chronic (long-term) studies in animals and people; however, the limited data available indicate that the subtle sub-chronic health effects demonstrated in test animals occurred at sulfolane doses that were several hundred-fold higher than those that could be obtained through consuming drinking water from North Pole area wells.

In addition to concerns about exposure to sulfolane from drinking water, many North Pole area residents are concerned about exposure to sulfolane from consuming garden produce that was grown with sulfolane-containing water. Some scientific studies indicate that plants can absorb sulfolane from water; however, no published studies are currently available on sulfolane uptake in edible garden plants. Therefore, a technical project team responsible for investigating sulfolane contamination in North Pole conducted a garden sampling project this past summer.

The purpose of the garden sampling project was to provide North Pole gardeners with some on-site data regarding the uptake of sulfolane in garden plants and to examine the potential for adverse health consequences of consuming produce from the gardens that were tested. A total of 27 types of plant parts from seven North Pole gardens were collected during July–September 2010. Different parts of plants (i.e. leaves, fruits, flowers, stems and roots) were tested for sulfolane content. The findings from this project are presented below. More information about this garden sampling project and the ongoing site investigation of the sulfolane contamination in North Pole's groundwater is available on the Alaska Department of Environmental Conservation (DEC) web site (see "Additional Resources" on page 5 for the URL).

Test Results for Sulfolane in Plants

The table below lists the types and parts of plants that were sampled, along with the range of sulfolane concentrations (levels) found in the plants. The range of sulfolane levels is shown in parts per billion (ppb). For reference, one ppb is roughly equal to one drop of water in an Olympic-size swimming pool. The table also shows how many samples of each type of plant were tested and how many samples had detectable levels of sulfolane.

Some samples are noted in the table as having an EMPC flag. The EMPC flag, or "*estimated maximum possible concentration*," means that the laboratory could not say for certain whether

sulfolane was present; however, if there, the *maximum* possible concentration that could be present in the sample is provided. For example, one carrot sample tested at 8.4 ppb sulfolane but that sample has an EMPC flag. This means that the lab could not be certain that what is in the carrot sample is sulfolane, but if so, the concentration of sulfolane would be no greater than 8.4 ppb. Given this uncertainty, all five samples with an EMPC flag were treated as though they have sulfolane in them.

Sulfolane Concentrations in Plant Samples by Plant Type and Part

Sample Type	Range of Results (ppb)	Number of Samples	Number of Detections	Notes
Beet root	ND – 15.2	3	1	
Beet leaf	28.4 – 198	2	2	
Broccoli	18.6	1	1	
Cabbage	11	1	1	
Carrot	ND – 8.4	4	1	EMPC
Cauliflower	ND – 15.9	2	1	EMPC
Crab apple	ND	1	0	
Cucumber	ND	2	0	
Currant	41.1	1	1	EMPC
Green leaf lettuce	25 – 92.8	3	3	
Green onion	ND	1	0	
Potato	8.9	1	1	EMPC
Radish root	ND	1	0	
Red leaf lettuce	41.4 – 64.8	2	2	
Rhubarb leaf*	ND – 118	5	3	
Rhubarb stem	ND	5	0	
Romaine lettuce	ND	1	0	
Shucking peas	ND	2	0	
Snap peas	ND – 12.5	3	1	
String beans	ND	1	0	
Summer squash	ND	1	0	
Swiss chard leaf	ND	1	0	
Swiss chard stem	ND	1	0	
Tomato	ND – 28.1	4	2	
White onion	ND	2	0	
Zucchini blossom (flower)	ND	1	0	
Zucchini fruit	ND – 24.7	4	1	EMPC

Table Key:
EMPC = estimated maximum possible concentration for detected sample
ND = not detected
*Note: rhubarb leaves are poisonous, and should not be eaten

In summary, the table shows that sulfolane was detected in the following parts of plants:

- Leaves (beet leaf, cabbage, green leaf lettuce, red leaf lettuce, and rhubarb leaf);
- Fruit (currant, snap pea, tomato, and zucchini);
- Flowers and stems (broccoli and cauliflower); and
- Roots (beet root, carrot, potato).

The following edible parts of plants showed no detectable levels of sulfolane:

- Crab apple
- Cucumber
- Green onion
- Radish root
- Rhubarb stem
- Romaine lettuce
- Shucking peas
- String beans
- Summer squash
- Swiss chard (leaf and stem)
- White onion
- Zucchini blossom

Test Results for Sulfolane in Well Water Used for Gardening

Samples of the well water used for gardening were collected at the same time as the garden plants. A total of 16 well water samples were collected from the seven locations. The sulfolane levels ranged from 31.5 to 247 ppb. In January 2010, the Agency for Toxic Substances and Disease Registry (ATSDR), recommended public health "action levels" of 25 ppb sulfolane in drinking water for infants, 40 ppb for children, and 87.5 ppb for adults. While the levels of sulfolane in the well water samples were above ATSDR's action levels, the well water is not being used for drinking purposes. Please refer to the fact sheet *Community Health Concerns about Sulfolane,* for more information about sulfolane in drinking water.

Comparison of Plants Results to DHSS Screening Levels

The Alaska Department of Health and Social Services (DHSS) has developed screening levels with which to compare the plant results from this project. These screening levels are based on the same toxicity data and uncertainty factors that ATSDR used to develop their action levels for sulfolane in drinking water. In addition, these screening levels are based on very protective risk assessment calculations that assume: 1) all consumed fruits and vegetables have some amount of sulfolane; 2) all consumed fruits and vegetables come from a sulfolane-affected garden; and 3) a person eats a lot more fruit and vegetables than the average person (i.e. in the 95th percentile). For adults, the screening value for sulfolane in fruits and vegetables is 233 ppb. In other words, a level of sulfolane below 233 ppb in these foods is unlikely to pose a health risk. For infants, the calculated screening value is 62 ppb.

Note that these screening values for sulfolane exposure from fruits and vegetables are <u>not</u> the same as the action levels for sulfolane in drinking water mentioned above. This is mainly because people consume much more water than fruits and vegetables. (See link for *DHSS Companion Guide to the ATSDR Health Consultation on Sulfolane* on page 5.)

What the Sulfolane Test Results of Garden Produce Mean for Human Health

The testing of produce from people's gardens involved a very limited number of samples, and therefore should be interpreted with caution. As previously stated, the purpose of this project was to provide North Pole gardeners with some on-site data regarding the uptake of sulfolane in garden plants, and to examine the potential for adverse health consequences of consuming

produce from the gardens that were tested. With only seven gardens, few samples of each plant, and the other factors that could affect the final levels of sulfolane in the plants — such as the amount of rainfall and level of sulfolane in the water — we cannot draw broad conclusions for all North Pole area gardeners about the safe use of sulfolane-affected water for growing fruits and vegetables. That said, the sampling results do provide valuable information to share with North Pole residents. Specifically, the results from this garden sampling project suggest that:

1. Edible garden plants can take up sulfolane that is present in water. People can be exposed to (come in contact with) sulfolane by eating affected produce.

2. Sulfolane was found in all parts of plants that were sampled (leaves, fruits, flowers, stems and roots). Results from earlier sampling suggested that sulfolane only concentrated in the leafy parts of plants, and not in the fruits, flowers, stems and roots.

3. Based upon what is known about sulfolane, the sulfolane levels in the plants tested from these gardens are low and not likely to cause any adverse health effects. However, this sampling project was limited, and only reflects the growing conditions this past year and only the produce from the sampled gardens. The amount of sulfolane in plants could be different based on a number of factors, including the type of produce, different growing conditions (i.e. more or less rainfall), or the amount of sulfolane in the well water. In addition, scientific information on the chronic health risks of sulfolane is lacking. Due to these unknown factors, we cannot say with 100% certainty that it is safe to use sulfolane-affected water for gardening without further study; therefore, watering gardens with sulfolane-free water is preferable until more information is available.

Next Steps

Flint Hills Resources has been working with EcoWater Systems to develop options for a household well-head treatment system. They submitted a draft feasibility study and design drawings last month to the State's Technical Project Team (TPT). This team, which includes experts in drinking water treatment, is evaluating this proposed system. An initial review suggests that activated carbon filtration technology appears promising for treating sulfolane. If it proves effective, installing this system is expected to begin early this year.

In addition, Flint Hills has agreed to offer homeowners the option of an installed above-ground water tank for watering gardens, along with delivered water during the growing season. Flint Hills will be contacting homeowners in January and February to discuss this, as well as other long-term options for household drinking water. The TPT will continue to track this issue to insure safeguards are available by the growing season.

The TPT, which also includes experts in the fields of toxicology and environmental chemistry, is coordinating with national laboratories and federal agencies to conduct more research on the toxicity of sulfolane. As stated previously, scientific information on the chronic health risks of sulfolane is a major data gap. This research effort will take at least several years to complete, but would ultimately give a much better scientific basis to protect human health and regulate this chemical. The current water supply and cleanup efforts will not be put on hold pending this research.

This spring, the Alaska Division of Public Health will issue a health consultation that discusses in detail the potential health risks from sulfolane exposure.

Please contact us with your questions and concerns

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Additional Resources

Previous fact sheets and other resources are available online, or you can call us for a copy:

- Alaska Department of Environmental Conservation North Pole Refinery Site Summary: http://www.dec.alaska.gov/spar/csp/sites/north-pole-refinery/

- *DHSS Results of the North Pole Garden Sampling Project: Testing of Early Harvest Plants for Sulfolane* (Aug. 16, 2010): http://www.epi.hss.state.ak.us/eh/sulfolane/DHSSGardenSamplingEarlyResultsFactSheet.pdf

- *DHSS Community Health Concerns about Sulfolane* (April 22, 2010): http://www.epi.hss.state.ak.us/eh/sulfolane/CommunityHealthConcernsSulfolane.pdf

- *DHSS Companion Guide to the ATSDR Health Consultation on Sulfolane* (Feb. 9, 2010): http://www.epi.hss.state.ak.us/eh/sulfolane/DHSSSulfolaneHCCompanion.pdf

- *DHSS Sulfolane Health Fact Sheet* (Jan. 12, 2010): http://www.epi.hss.state.ak.us/eh/sulfolane/SulfolaneHealthFactSheet.pdf