Update on Sulfolane Cleanup

February 3, 2010

Sulfolane is a chemical solvent using in refining oil. It has been found in the groundwater at the North Pole Refinery and in 54 private wells near to the refinery property. The Alaska Department of Environmental Conservation is overseeing the removal of sulfolane from groundwater from previous gasoline spills. The agency is working with refinery owners Flint Hills Resources LLC to ensure residents whose private wells have tested positive for sulfolane have access to bottled water. It is also working with Flint Hills and the City of North Pole to explore other drinking water source and treatment options. The Alaska Department of Health and Social Services (DHSS) is evaluating the sulfolane situation for potential long-term human health impacts.

Topics in this Fact Sheet.....

Concerned citizens have called with questions about drinking water sources, health impacts, the status of the cleanup and other topics. In this fact sheet, we offer information on the status of the cleanup. We will address this topic in a Question and Answer format. Some readers may find the information too technical; others may seek additional details. Please feel free to call or email us if you need clarification or more information. See contact information at the end of this paper. We also encourage you to view our website—for facts sheets, history of sulfolane use at the refinery and other information.

1. GROUNDWATER

Q: How do you clean up groundwater contaminated with sulfolane?

A. Once contaminants have sunk through the soil and into the zone saturated with groundwater, cleanup is very time-consuming and can take several years or even decades. The contamination is typically beyond the reach of a backhoe, so digging it up is usually impossible. In the refinery's situation, the most effective means to ultimately clean the groundwater is to pump the petroleum products and water back out of the ground. where the highest concentrations of sulfolane are. Flint Hills and the previous owner, The Williams Companies, have been operating this remediation system since 1988 to remove spilled petroleum. Petroleum does not dissolve easily in water but sulfolane does, so the petroleum contamination has remained on the refinery property. Sulfolane, however, has spread through a much wider area of groundwater. DEC is working with Flint Hills on improving the efficiency of their remediation system.

Q: How clean can contaminated groundwater become?

A. Several government agencies are charged with setting standards for chemicals, standards which set how much of a chemical must be removed before we can be confident that people will not have some harmful health effect. Cleaning groundwater to a concentration of zero is very difficult. Agencies designate a concentration of a given chemical as a standard, meaning soil or water should not have more than that amount in order to present a very low risk to anyone exposed to it. Designed for various situations, these levels can be advisory (meaning they are used to guide government, but not set in law) or enforceable (meaning they are set in law). The primary levels which apply to the sulfolane issue are for drinking water and cleanup of contaminated groundwater.

2. CHEMICALS AND GOVERNMENT REGULATION

Q. How are standards for chemicals in the environment made?

A. Research on the health effects of a chemical is performed on laboratory animals, and conclusions can be drawn about human health effects. Comprehensive research consists of multiple studies, considering exposure over short and long periods of time, high doses and low doses. Studies of people who have already been exposed

to a chemical, at the workplace or in other circumstances, help improve our understanding of human health effects. Scientists, and regulators, incorporate various safety factors in calculations to convert doses considered safe for animals to doses for humans. Agencies then apply this "toxicity" data to various life situations that represent the many ways in which people could be exposed: how much, how often, when, where, etc. and arrive at desired maximum concentrations. These levels are also developed to protect plant and animal populations. Levels can be set in regulation and become enforceable.

Q. Who sets standards for drinking water contaminants?

A. The U.S. Environmental Protection Agency (EPA) sets drinking water regulatory standards called maximum contaminant levels (MCLs) for over 90 microbiological and chemical contaminants. Public water systems are required to meet these levels "at the tap," or, after any water treatment. EPA reviews each national primary drinking water regulation at least every six years.

The State of Alaska's Drinking Water Program, which is run by DEC, enforces EPA's program for public water systems in Alaska. This means the DEC's regulatory standards for public drinking water are the same as EPA's. DEC does not have authority to regulate water in private wells.

Q. What if a chemical is not listed in regulations about drinking water?

A. For contaminants not included on EPA's list, DEC can develop an advisory level. Since the federal Agency for Toxic Substances and Disease Registry (ATSDR) is about to come out with a recommended level for sulfolane in public drinking water, DEC will very likely use that level for public water systems.

Q. Who sets standards for soil and groundwater cleanup?

A. EPA lists in regulation a number of chemicals as hazardous substances and sets standards for some, such as polychlorinated biphenyls (PCBs) and lead. EPA has "screening levels" for hazardous chemicals at sites where EPA is the lead regulatory agency. These screening levels are used to help identify contaminants that require further attention at a site. Screening levels may not end up as the site's cleanup levels.

In Alaska, DEC is the lead regulatory agency for most contaminated sites. DEC, not EPA, regulates cleanup of petroleum contamination at all sites. EPA is involved in some but not all Alaska sites with contamination from other hazardous substances. DEC's Contaminated Sites Program sets standards in regulation for many contaminants so that soil and groundwater will be cleaned to these levels. In 1999 DEC's initial cleanup regulations used the Environmental Protection Agency's list of hazardous substance and calculations. Other contaminants have been added to this list over the years.

For cleanup of contaminated groundwater, DEC uses EPA's drinking water MCL, if one exists. DEC applies this level to the groundwater aquifer itself, rather than at the tap. This approach helps protect the aquifer for drinking water.

Q. What if a chemical is not listed in regulations about soil and groundwater cleanup?

A. DEC uses a risk assessment approach adopted from EPA to calculate a groundwater cleanup level for a chemical in the absence of a federal MCL. DEC calculates risk-based cleanup levels from scientific research on the toxicity of the substance and assumptions about exposure (see box next page). DEC can also calculate a cleanup level for a particular site which takes into account local conditions, such as how the land and groundwater are used.

3. UPDATE ON THE SULFOLANE CLEANUP LEVEL

In 2001, DEC learned that sulfolane was present in gasoline-contaminated groundwater on the refinery's property. Monitoring of the gasoline plume then began to include sulfolane. DEC then considered benzene to be the contaminant of the highest risk to people in the plume because benzene is highly toxic nature and known to cause cancer. The petroleum plume remained on the refinery property, and no monitoring wells were placed at the property's northern edge at that time. In 2005 DEC saw the need to develop a sulfolane cleanup level for the refinery's formal cleanup plan.

Toxicity information was unavailable for sulfolane in the places DEC consults first (see Tiers 1 and 2 in the box at right). DEC then sought other resources (Tier 3).

DEC selected a toxicity value to calculate a cleanup level from the Canadian document *Water Quality Guidelines for Sulfolane*, prepared by Komex International Ltd. for the British Columbia Ministry of Water, Land and Air Protection, October 2001. This document compiled all of the latest available primary toxicological studies, including a Chinese study, and derived a Tolerable Daily Intake. The Chinese study, *An investigation of maximum allowable concentration of sulfolane in surface water,* written by Zhu Zhenhua, et al, arrived at a more protective toxicity value, but the Canadian report did not use this study's toxicity value because of questions about scientific procedures and reliability.

How Risk-based Cleanup Levels are Calculated

a) **Toxicity value** – DEC uses the sources below for toxicity criteria in this order:

Tier 1: EPA's Integrated Risk Information System (IRIS).

Tier 2: EPA's Provisional Peer Reviewed Toxicity Values (PPRTV).

Tier 3: Additional EPA/non-EPA sources of toxicity information. Priority is given to information that is most current, peer reviewed, transparent and publicly available.

b) **Assumptions:** DEC assumes a body weight of 70 kilograms, or 154 pounds, exposure (for ingestion of groundwater) over 350 days per year for 30 years, ingesting two liters of water per day.

c) **For carcinogenic contaminants** – the excess cancer risk factor shall not exceed the possibility of 1 person in 100,000 people (1×10^{-5}) getting cancer from the substance. This is in addition to the risk to the public for cancer in general.

d) **For non-cancer-causing contaminants** -- DEC uses a "target hazard quotient." The hazard index is "1," which is the level at which people are not expected to experience any adverse health effects as a result of exposure to site contaminants.

With the Canadian study's toxicity value, DEC calculated a "project action level," which means it was a risk-based level not yet put in regulation as a cleanup level. Cleanup levels in regulation undergo public review before being set. The project action level, however, became a "regulatory" level when put into Flint Hills' "corrective action plan." The project action level was 350 micrograms per liter, or 350 parts per billion, sulfolane in groundwater. (See box next page for details on the calculation.) This level of sulfolane became Flint Hills' goal – to have the the groundwater concentration not exceed 350 parts per billion at the edges of the petroleum plume. Monitoring wells were checked for petroleum-related contaminants of concern and sulfolane. Results between 2006-2009 indicated stable or decreasing trends. During Flint Hills' review of the data in the summer of 2009, there was a slightly increasing trend of sulfolane concentrations in several wells within the plume, This prompted installation of additional wells that autumn at the northern boundary of the refinery to test for sulfolane. Positive results in these wells that October sparked Flint Hills' effort to contact property owners with private wells. The company, with DEC oversight, also began to test further to the north and northwest, in the direction of groundwater flow, to determine the edges of the sulfolane plume. Tests of petroleum plume continued to show that it remains within the refinery property.

Q. Will DEC change its cleanup level?

A. DEC's Drinking Water Program and the City of North Pole will incorporate the advisory levels into the monitoring and treatment program for the City's Water Treatment Plant. DEC's Contaminated Sites Program will use ATSDR's toxicity evaluation to set a cleanup level for ongoing remediation on the refinery property

and to reconsider the risks from sulfolane at off-site locations. Regulations will be updated, if appropriate, to incorporate a new cleanup level for sulfolane.

Note that DEC does not regulate private wells, but Flint Hills has committed to providing a permanent alternate water source for wells impacted by sulfolane. The company plans to work with the City and individual landowners to make that happen in 2010.

Q. What's the history of DEC's sulfolane cleanup level?

A. DEC learned through the October 2009 tests that residents with private wells could be drinking water with sulfolane at levels higher than expected, although still below the 350 parts per billion cleanup level. Also, the City of North Pole wells were ¾-mile in the general direction, although not direct, of groundwater flow. DEC then exercised caution by reexamining its project action level. Tests of private wells, beginning in November 2009, showed sulfolane present in some. The city water supply shows traces of sulfolane in raw water, but treatment removes it.

DEC again researched available toxicity data and found no more current data available than a 2006 Canadian Council of Ministers of the Environment report that used the same toxicity factor DEC used to calculate the project action level. DEC also asked the Alaska Department of Health and Social Services (DHSS) for their help in determining the health implications of sulfolane at the levels found in private well water at North Pole and in talking with the community on health-related questions about the site.

Meanwhile, at DEC's request, EPA evaluated and concurred with the DEC's initial use of the Canadian toxicity value. DHSS requested assistance from its federal partner on public health issues, the Agency for Toxic Substances and Disease Registry (ATSDR), to evaluate the scientific literature and assist in the toxicological analysis.

There remains no state or federally recommended screening level for sulfolane, and the various agencies are working toward agreement on the toxicity factor to on which to base government levels. EPA's Superfund Health Risk Technical Support Center has agreed to place sulfolane in its queue for evaluation for a Professionally Peer Reviewed Toxicity Value. Concurrently, ATSDR is reviewing the toxicological literature in order to develop a public health action level.

When ATSDR completes its analysis and provides a recommended public health advisory level for sulfolane, expected in early February, DHSS will write a health consultation to place the ATSDR value into context, answer health-related questions from the community, and develop recommendations that are both feasible and protective of public health.

How DEC calculated the 350 parts per billion Sulfolane cleanup level

The Mathematical Equation: from DEC's 2008 Cleanup Levels Guidance, we used Equation 1, Table C: Groundwater Cleanup Level Equation for Non-Carcinogenic Contaminants.

The Toxicity Factor: we used an oral reference dose of 0.0097 milligrams per kilogram of bodyweight per day, the Canadian report's Tolerable Daily Intake, (*Water Quality Guidelines for Sulfolane,* by Komex International Ltd., October 2001.)

The exposure assumptions: (see box, previous page) used in DEC's cleanup level equation are based on standard exposure parameters that represent reasonable maximum exposure conditions for long-term/chronic exposures. They are based on the methods outlined in EPA's *Risk Assessment Guidance for Superfund, Part B Manual*.

Alaska Department of Environmental Conservation
Spill Prevention and Response Division, Contaminated Sites Program, www.dec.alaska.gov/spar/csp/
North Pole Refinery site summary: www.dec.alaska.gov/spar/csp/sites/npolerefinery.htm
For more information: on contaminated sites, contact Marti Early, DEC, 907-465-5206, marti.early@alaska.gov
on health related information, contact Nim Ha, DHSS, 907-269-802, nim.ha@alaska.gov
on public water supplies, contact Cindy Christian, DEC 907-451-2222 cindy.christian@alaska.gov
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