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**Health Consultation**

**Hills, Iowa Perchlorate Groundwater Contamination Site  
2012 Update**

**Hills, Johnson County, Iowa**

**CERCLIS No. IAN000704368**

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## **Purpose**

The Iowa Department of Natural Resources (IDNR) has requested that the Iowa Department of Public Health (IDPH) complete an update of the health consultation for the Hills, Iowa Perchlorate Groundwater Contamination Site that was originally completed in June 2004. In this updated health consultation, the IDPH will: 1) summarize background information on this site, 2) summarize the progress of work that has been completed regarding the site, 3) summarize the environmental data that has been collected, 4) summarize toxicological information and regulatory information regarding perchlorate, and 5) provide an update to any conclusions and recommendations from the Iowa Department of Public Health.

The Iowa Department of Public Health's priority is to ensure the Hills community has the best information possible to safeguard its health and the IDNR has the best information to guide its activities. That information is included in the following paragraphs.

## **Background**

Hills is a town within Johnson County, Iowa, approximately 10 miles south of Iowa City, Iowa. The town has a population of approximately 662 residents. A majority of the town has shallow sand point private wells (approximately 20-foot deep) that are used as the source of drinking water for residences and businesses (1). Perchlorate has been detected in some of these private wells and within the groundwater beneath Hills, Iowa. Groundwater sampling began in 2001 and has continued. Sampling and analysis of private wells in Hills began in 2001 and has continued.

In the health consultation that was prepared in 2004 a summary of the sampling and analysis of private wells that had been completed up to that date was included. From 2001 to 2004, private wells had levels of perchlorate at levels ranging from 0.45 to 66  $\mu\text{g/L}$  (micrograms per liter) or ppb (parts per billion).

## **Contaminant of Concern**

The contaminant of concern at the site is perchlorate that has been found in the groundwater and private and community wells in Hills, Iowa. Perchlorate is an ionic compound made up of chlorine and oxygen ( $\text{ClO}_4^{-1}$ ) that can be either naturally occurring or man-made. It may be present in ground and surface waters as a breakdown of ammonium, potassium, magnesium, or sodium salts that contain perchlorate. Perchlorate salts have been used as oxidizing components in solid propellants for rockets, missiles, and fireworks for over 50 years. Perchlorates are also used in tanning and leather finishing, electroplating, aluminum refining, and rubber manufacturing. Perchlorate can also be found as an inert constituent in some fertilizers.

At the present time the U.S. Environmental Protection Agency (EPA) has not established a maximum contaminant level (MCL) for perchlorate in drinking water. An MCL is the legally enforceable federal standard that applies to all public drinking water systems. When determining an MCL, EPA considers the level at which a person could drink 2 liters of water containing the



contaminant every day for 70 years without suffering any ill effects. Although EPA does not have an MCL for perchlorate at this time, the EPA has now recently decided to regulate perchlorate under the Safe Drinking Water Act (SDWA) and to initiate the development of a national primary drinking water regulation (NPDWR) and the possible establishment of an MCL.

### **Efforts Made on Behalf of Hills Residents**

At the time of the health consultation in 2004 the EPA had established a provisional cleanup range for perchlorate from 4 to 18 ppb. It was decided that residents whose private wells had been impacted by perchlorate at concentrations above 18 ppb would be provided bottled water by EPA. Bottled water was provided to these residences and one business in September 2003, and continued until July 2005. In July 2005, point-of-use reverse osmosis water treatment units were installed by EPA at 17 residences within Hills. Once these treatment units were installed, the City of Hills has been responsible for the maintenance and servicing of these units. The use of these point-of-use reverse osmosis treatment units have continued at the time of the preparation of this health consultation. Seven additional units have been installed by the City of Hills since the initial installation of units in July 2005. At the present time, there is 24 point-of-use reverse osmosis water treatment units in use within the Hills community.

In June 2007, the City of Hills authorized work to be developed on plans for a municipal water system for the Hills community. A plan was developed and brought to the citizens of Hills for a vote at the November 2007 general election. The plan for a municipal water system was not passed by the citizens of Hills. At the present time the City of Hills continues to look into possibly funding for a municipal water system. The City of Hills has also periodically checked with Wapello Rural Water Association to explore opportunities of connecting to their water supply network.

Plans were made on behalf of the City of Hills by an engineering consultant to install a series of groundwater dewatering wells to address the perchlorate groundwater contamination. The City of Hills previously made application of a National Pollutant Discharge Elimination System (NPDES) permit to the IDNR for the discharge of the water from these wells that were to be installed. The decision to grant this permit was put on hold by the IDNR and the City of Hills withdrew their NPDES permit application and at the present time these groundwater dewatering wells have not been installed.

### **Continued Monitoring of Perchlorate in Private Wells**

Since the completion of the previous health consultation in 2004 the monitoring of the concentration of perchlorate within private well water has continued. Sampling and analysis of raw water from the private wells and from well water after it had been treated by the reverse osmosis units has been completed from 2006 through 2010. The following table includes a summary of the range of perchlorate concentration within the raw private well water and well water after treatment by the reverse osmosis units.



**Table 1 – Levels of Perchlorate in Private Wells (2006 to 2010) (1)**

Point of Sampling and Analysis	Range of Level of Perchlorate (ppb)
Raw Private Well Water (All Uses)	<4 to 230
Raw Private Well Water (Potable Uses)	<4 to 130
Well Water after Reverse Osmosis Treatment	<4 to 11

As can be seen in Table 1 the highest level of perchlorate in all private well water was 230 ppb. This highest level was found in a private well that is not used for potable or drinking water uses. The highest level of perchlorate found in private wells used for drinking water was found to be 130 ppb. The highest level of perchlorate found in well water after being treated by the reverse osmosis was 11 ppb. This high level of 11 ppb found in well water after being treated by the reverse osmosis units was found only once and in only one sample. After the level of 11 ppb perchlorate was found in this treated water, maintenance was completed for the reverse osmosis treatment unit and the treated water was retested and found to contain perchlorate below the laboratory detection level (<4 ppb). For all other sampling and analysis of treated water the level of perchlorate was below the laboratory detection level (<4 ppb).

**Community Health Concerns**

As part of the previous health consultation, the IDPH participated in public presentations and individual one-on-one meetings discussing the perchlorate contamination of groundwater in Hills. The IDPH received and responded to concerns from the public regarding their health and impacts that perchlorate may have. Previously concerns that were voiced by the Hills community included a perception that there was no safe level of exposure to perchlorate. This concern was answered by the IDPH by discussing the dose / response concept with the public. It was explained that health effects from exposure to perchlorate occur only after a sufficient dose (or amount) of perchlorate is ingested. It was further explained that the levels of perchlorate that the community had been exposed to would likely not cause long-term adverse health effects. It was also further discussed that the precautionary efforts made by EPA and others to provide bottled water and to provide point-of-use reverse osmosis units to homes with levels of perchlorate above 18 ppb were protective of human health.

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## Discussion

### Exposure To Perchlorate

Exposure to perchlorate is determined by determining human exposure pathways. An exposure pathway has five parts:

1. A source of contamination,
2. An environmental medium such as air, water, or soil that can hold or move the contamination,
3. A point at which people come in contact with a contaminated medium, such as, in drinking water, or in surface soil,
4. An exposure route such as, drinking water from a well, or eating contaminated soil on a homegrown vegetable, and
5. A population who could come in contact with the contaminants.

An exposure pathway is eliminated if at least one on the five parts is missing and will not occur in the future. For a completed pathway, all five parts of the pathway must exist and exposure to a contaminant must have occurred, is occurring, or will occur. An exposure pathway to perchlorate was completed when residents of Hills ingested well water prior to the use of bottled water or the use of point-of-use reverse osmosis treatment units. However, the exposure pathway for residences above the level of 18 ppb was broken when the residents were provided with bottled water. This broken exposure pathway has continued with the installation of the point-of-use reverse osmosis treatment units

### Toxicological Evaluation

#### *Human Health Impact From Perchlorate*

Human exposure to perchlorate occurs through ingestion of drinking water that contains perchlorate. Absorption of perchlorate through the skin does not readily occur. In addition, perchlorate does not volatilize easily from water or stream so that the presence of perchlorate in well water poses no health concern due to inhalation.

**High doses** of perchlorate are known to impact the function of the thyroid gland in humans, and in the past have been used as a pharmaceutical. Over 50 years of use as a medication has provided much information about perchlorate's interaction with body chemistry, and possible health risks (2). Perchlorate does not cause cancer in humans, cell mutagenesis or genetic damage, and it does not cause harm to the human immune system. In adults, perchlorate has limited biochemical effects, and these effects are limited to the thyroid gland (2).

**High doses** of perchlorate, (in the milligrams per day range) are needed to interfere with the iodide uptake into the thyroid gland sufficiently enough to produce hypothyroidism in the affected individual. The following sequence of events, are necessary for adverse health effects to occur in the case of perchlorate exposure. 1) A threshold amount of perchlorate must be ingested to inhibit iodide uptake into the thyroid gland. 2) A large percentage of normal iodide uptake

must be prevented for a long time to deplete the thyroid gland's iodine reserve, and cause a reduction in the thyroid hormone, thyroxine. 3) A reduction in thyroxine must be large enough to overwhelm the body's homeostasis process in which the pituitary gland releases thyroid stimulating hormone to cause the thyroid to produce more thyroxine. If all this happens, then hypothyroidism could result (2).

In adults, the thyroid helps to regulate metabolism. When the thyroid is affected, thyroid hormone production may decrease which can negatively affect metabolic rate. This may cause signs of hypothyroidism, such as enlargement of the thyroid gland (a goiter).

Perchlorate is not stored in the body, and impacts to the thyroid gland from exposure to high amounts of perchlorate will be reversed once the exposure to these high levels of perchlorate is discontinued.

### ***Human Health Studies***

The following paragraphs summarize information obtained from several human health studies involving perchlorate. These studies are presented to provide information on impacts to human health from exposure to perchlorate in drinking water at levels similar to the levels of perchlorate in private well water in Hills, Iowa.

Two health studies of the effects of perchlorate in drinking water in the states of Nevada and California were completed. In one study, an analysis of the Medicaid database from Nevada was undertaken to determine whether an increase in the prevalence of any thyroid disease was associated with levels of perchlorate in drinking water at 4 to 24 ppb (3). This study found no evidence that perchlorate-containing drinking water at levels ranging from 4 to 24 ppb increases the prevalence of acquired hypothyroidism or of any other thyroid condition. In the other study, data from the state health departments in California and Nevada were analyzed for any increase of congenital hypothyroidism (hypothyroidism acquired during fetal development) in counties that had levels of perchlorate in drinking water supplies at levels ranging from 4 to 16 ppb (4). The study found no evidence that perchlorate-containing drinking water at levels ranging from 4 to 16 ppb increased the incidence of congenital hypothyroidism.

An additional study was conducted to investigate the potential effects of perchlorate in drinking water on thyroid function in newborns and school-age children in northern Chile (5). The level of perchlorate in drinking water in northern Chile can be as high as 100 to 120 ppb. The findings of this study indicated that perchlorate in drinking water as high as 100 to 120 ppb did not suppress thyroid function in newborns or school-age children.

### ***EPA's Perchlorate Action Level***

In an effort to assess the risk posed by individual chemicals, the EPA establishes a reference dose (RfD). The RfD is defined as, "an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime". In an effort to

develop a human health oral risk benchmark for perchlorate, the EPA established, in 1999, a provisional RfD range of 0.0001 to 0.0005 mg/kg-day for perchlorate-related assessment activities. In determining this provisional RfD range, the EPA utilized data on the effects of perchlorate to rat thyroid tissue and then added safety factors of several orders of magnitude to calculate the above provisional RfD range.

In order to determine the concentration of perchlorate in drinking water that would result in an exposure equal to the RfD, assumptions need to be made regarding human consumption of drinking water and average weight. EPA assumes that adults ingest an average of 2 liters of water per day and on average weigh 70 kg. By applying these assumptions to the provisional RfD range of 0.0001 to 0.0005 mg/kg-day, a provisional cleanup level in water would range between 4-18 ppb for perchlorate was established by the EPA. The EPA has previously used the upper limit of this range (18 ppb) as the action level for providing bottled water and the point-of-use reverse osmosis treatment units to residents in Hills, Iowa.

In 2005, after completion of the initial health consultation, EPA established a final RfD. This RfD is available as part of the US. EPA Integrated Risk Information System and has been determined to be 0.0007 mg/kg/day (6). The RfD has been based upon a level where no impact was observed in the ability of the thyroid gland to uptake iodine within healthy adults. The determination of the RfD for perchlorate is not based upon a measurement of an adverse health impact, but a biochemical precursor to a potential adverse health impact. As a result, the determination of the RfD for perchlorate is more conservative than most RfD determinations. A 10-fold safety factor is also used in the calculation of the RfD and is applied in order to determine an exposure level below which there is virtually no human health risk, even to sensitive subgroups.

Applying the assumptions that adults ingest an average of 2 liters of water per day and on average weigh 70 kg, a preliminary remediation goal of 24.5 ppb was considered by EPA. In 2009 the EPA announced that it planned to seek additional assistance from the National Academy of Sciences (NAS) regarding the possible effect of perchlorates on infants and young children. Around the same time, EPA's Office of Water published an interim health advisory level (IHAL) of 15 ppb. This IHAL takes into account perchlorate exposure from food, as well as drinking water, for pregnant women and their fetuses (the most sensitive life stage identified by the NAS). Following the establishment of the IHAL, EPA's Office of Solid Waste and Emergency Response withdrew its preliminary remediation goal for perchlorate of 24.5 ppb, and replaced it with the IHAL of 15 ppb to be used as the preliminary remediation goal (7).

### ***Protectiveness of EPAs Preliminary Remediation Goal***

Considering the above referenced human health studies and the method of determination of EPA's Preliminary Remediation Goal, it can be concluded that the preliminary remediation goal of 15 ppb that is now being applied by EPA in Hills, Iowa, is protective of human health, even for sensitive sub-populations.

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## Children and Sensitive Populations

Children are not simply small adults. Pound for pound, children drink more liquid and breathe more air than adults. Therefore, children must be considered separately from adults when exposures are being determined. In children, the thyroid plays a major role in proper development and metabolism. Infants and small children have less reserve of iodine in their thyroid gland than adults, putting them at higher risk. Impaired thyroid function in pregnant women may impact the fetus or newborn resulting in changes in behavior, delayed development, and decreased learning capability. Thus, exposure to perchlorate in drinking water may be a greater concern for women and the developing fetus. This greater concern for the impact of perchlorate on the developing fetus in pregnant women who might have undiagnosed hypothyroidism or iodine deficiency is the reason for the choice of the level of protectiveness in the RfD for perchlorate and in the determination of EPA's Preliminary Remediation Goal.

EPA's Preliminary Remediation Goal of 15 ppb is now considered the level at which point a point-of-use reverse osmosis treatment unit is to residents in Hills. With this precautionary step in providing these treatment units, the IDPH concludes that no individuals in Hills, Iowa are exposed to levels of perchlorate that can adversely impact their health.

## Summary Discussion

Perchlorate has been found in private well water within Hills, Iowa, at concentrations ranging from <4 to 230 ppb. Perchlorate has been found in potable private well water up to 130 ppm. Currently, point-of-use reverse osmosis units are being provided to residents that have private wells that are impacted by perchlorate at concentrations above 15 ppb.

Community concerns have been voiced regarding past exposures to well water that is contaminated with perchlorate. Human health studies indicate that perchlorate concentrations in drinking water up to 15 ppb (EPA's Preliminary Remediation Goal and the current action level in Hills) will not adversely affect human health, including sensitive sub-populations. Since the exposure to levels above 15 ppb perchlorate within the private drinking water wells has been eliminated, any adverse health impacts to the thyroid gland that may have occurred from exposure to perchlorate can be considered to be reversed and eliminated for individuals currently living in Hills, Iowa.

## Conclusions

- The Iowa Department of Public Health concludes that exposure to water that is currently available from private wells in Hills, Iowa is not expected to harm people's health, provided that point-of-use reverse osmosis treatment units are utilized for private wells with raw water containing perchlorate above 15 ppb.
- The current action level of 15 ppb and the utilization of point-of-use reverse osmosis treatment units by residents is protective of human health.



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## Recommendations

- The point-of-use reverse osmosis treatment units should continued to be utilized until a more permanent source of safe potable water is made available to the residents of Hills, or until perchlorate levels in raw water consistently decline to below 15 ppb.
- An investigation to more accurately determine the source of perchlorate contamination and its possible elimination should be completed.

## Public Health Action Plan

- IDPH will provide assistance with community health education as needed and requested.
- IDPH will continue to review private well monitoring data provided and update health recommendations as necessary.
- IDPH will work with the EPA and IDNR to follow up with Hills residents to address any health concerns.



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## References

1. Hills Perchlorate Site, Electronic Files, Iowa Department of Natural Resources.
2. Richard C. Pleus, Ph.D., "Using Good Science to Derive a Safe Drinking Water Level," Water Conditioning and Purification, August 2003.
3. F. X. Li, et al., "Prevalence of Thyroid Diseases in Nevada Counties With Respect to Perchlorate in Drinking Water," Journal of Occupational and Environmental Medicine, 2001 Jul;43(7):630-4.
4. S. H. Lamm and M. Doemland, "Has Perchlorate in Drinking Water Increased the Rate of Congenital Hypothyroidism," Journal of Occupational and Environmental Medicine, 1999 May;41(5):409-11.
5. C. Crump et al., "Does Perchlorate in Drinking Water Affect Thyroid Function in Newborns or School-Age Children," Journal of Occupational and Environmental Medicine, 2004 Jun;46(6):516-17.
6. Integrated Risk Information System Data for Perchlorate Salts, EPA Web link: <http://www.epa.gov/iris/subst/1007.htm>
7. Site Status Summary – Highway 218 Superfund Perchlorate Site, Hills, IA. U.S. Environmental Protection Agency.



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