Iowa Department of Public Health
Promoting and Protecting the Health of Iowans

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Clinton County Residents
Camanche, IA

RE: Health Consultation
Private Drinking Water Wells – Camanche, IA

Dear Clinton County Residents:

This letter has been prepared as a consultation to evaluate human health impacts from the use of private drinking water wells in Clinton County, Iowa. These wells are located just to the west of Highway 67 and Camanche, Iowa and near 9th Street, 31st Avenue, and 37th Avenue. The wells are also located to the south of contaminated sites known as Chemplex and PCS Nitrogen, and near former disposal areas known as Todtz Landfill and Doty Landfill.

The Iowa Department of Public Health's priority is to ensure the Clinton County community has the best information possible to safeguard its health. That information is included in the following paragraphs.

Background and Statement of Issues

The Iowa Department of Public Health was contacted by a resident of Clinton County regarding the safety of continuing to use the private drinking water wells located west of Highway 67 and Camanche, Iowa. Owners of homes where these private wells are located have the option of connecting to a public water supply from the City of Camanche. The resident who contacted the Iowa Department of Public Health wanted to know of the health risks if people elected not to connect to public water, but planned to continue to use their private water wells for drinking and cooking. Since the time of the initial contact by the resident of Clinton County, public water has been delivered to this area and some of these residents have connected to this public water and are not utilizing their wells as their potable water supply.

Private water wells in this area of Clinton County have been sampled and analyzed for a variety of chemicals and substances as part of environmental investigations conducted by the U.S. Environmental Protection Agency, the Iowa Department of Natural Resources, and the Clinton County Health Department. Data from investigations of the sites known as Chemplex, Doty Landfill, PCS Nitrogen, and Todtz Farm Landfill were reviewed to obtain information on the levels of chemicals within samples obtained from the private water wells located west of Highway 67 and Camanche, Iowa. The data that was reviewed was from sampling and analysis results from 1992 until 2008 for up to 22 wells for each contaminant. As such the evaluation completed with this consultation addresses previous exposures to these wells. An evaluation of current and future risks would need to be completed on sampling analysis of wells that is current and will be completed in the future.

Some of the data reviewed in this consultation was from private wells that are no longer in use since the owners of these wells have now connected to the public water supply. In this case, the evaluation completed by this consultation would only apply to previous exposure to water from these wells.

As a method of determining the potential for adverse health impacts from utilizing water from these private wells, it is necessary to first look at the highest level of chemicals found within these private wells. The highest level of chemicals found within the private wells can then be compared to chemical levels that are known to cause adverse health impacts. The highest concentration of the chemicals that were measured in these private wells is included within the table on the following pages. The table also includes comparison values for the chemicals. Comparison values are explained within the paragraphs following the table.

Table 1 – Maximum Concentration and Comparison Values of Chemicals Found within the Private Well located West of Highway 67 and Camanche, Iowa (1).

Chemical Parameter	Concentration (mg/L)[1]	Comparison Value (mg/L)
Acetone	0.022	9.0[4]
Anthracene	ND	-
Acenaphthalene	ND	-
Acenaphthene	ND	-
Ammonia as N	3.6	30.0[5]
Arsenic, total	0.03	0.01[6]
Barium	0.485	2.0[6]
Benzene	0.030	0.005[6]
Benzo(a)anthracene	ND	-
Benzo(a)pyrene	ND	-
Benzo(b)fluoranthene	ND	-
Benzo(g,h,i)perylene	ND	-
Benzo(k)fluoranthene	ND	-
2-Butanone	ND	-
Cadmium, total	ND	-
Carbazole	ND	-
Carbon disulfide	ND	-
Carbon tetrachloride	ND	-
Chloride	63	250[7]
Chlorobenzene	ND	-
Chloroform	0.002	0.070[5]
Chrysene	ND	-
Chromium, total	0.03	0.010[8]
Coliform, total	5.1[3]	5%[9]
Cobalt	0.00781	0.1[8]
Copper, total	0.127	0.1[8]
Dibenzo(a,h)anthracene	ND	-
Dibenzofuran	ND	-
1,4-Dichlorobenzene	0.0007	0.075[6]
o-Dichlorobenzene	ND	-
p-Dichlorobenzene	ND	-
1,1-Dichloroethane	ND	-
1,2-Dichloroethane	ND	-
1,1-Dichloroethylene	ND	-
cis-1,2-Dichloroethylene	ND	-
trans-1,2-Dichloroethylene	ND	-
1,2-Dichloropropane	ND	-
Dissolved solids, total	1,010	-
Ethylbenzene	ND	-

[1] mg/l is milligram per liter
[2] ND means not detected
[3] Units for Coliform, total is MPN per 100 ml, or most probable number of total coliforms per 100 milliliters
[4] Comparison value obtained from the EPA Reference Dose
[5] Comparison value is EPA Lifetime Health Advisory
[6] Comparison value is EPA Maximum Contaminant Level
[7] Comparison value is EPA Secondary Drinking Water Standard
[8] Comparison value is obtained from ATSDR Minimal Risk Level
[9] Comparison value is EPA drinking water standard of no more than 5% of the samples testing positive for coliform

Table 1 – Maximum Concentration and Comparison Values of Chemicals Found within the Private Well located West of Highway 67 and Camanche, Iowa (1). (Cont.)

Chemical Parameter	Concentration (mg/L)	Comparison Value (mg/L)
bis(2-Ethylhexyl)phthalate	0.028	0.002[6]
Fluoranthene	ND	-
Fluorene	ND	-
Indeno(1,2,3-cd)pyrene	ND	-
Lead, total	0.15	0.015[7]
Manganese	1.38	0.3[8]
Mercury, total	ND	-
Methylene chloride	0.0014	0.005[8]
Methyl ethyl ketone	ND	-
2-Methylnaphthalene	ND	-
4-Methylphenol	ND	-
Naphthalene	0.0025	0.1[8]
Nickel, total	0.187	0.1[8]
Nitrate as N	4.5	10[8]
Nitrate + Nitrite as NO_3	119	10[8]
Pentachlorophenol	0.00055	0.001[8]
pH	6.4-9.1[3]	6.5-8.5[3,10]
Phenanthrene	0.0017	-
Phenol	ND	-
Pyrene	ND	-
Radon-222	699[4]	300[11]
Silver, total	ND	-
Sodium, total	360	-
Specific conductance	1,500	-
Styrene	0.0056	0.1[8]
Tetrachloroethylene	ND	-
Thallium	0.00103	0.0005[8]
Total hardness	660	-
Total organic carbon	6.6	-
1,2,4-Trichlorobenzene	ND	-
1,1,1-Trichloroethane	ND	-
1,1,2-Trichloroethane	ND	-
Trichloroethylene	0.0052	0.005[8]
Vanadium	ND	-
Vinyl Chloride	ND	-
Xylenes, total	0.0007	2.0[12]
Zinc, total	0.63	2.0[9]

[1] mg/l is milligram per liter
[2] ND means not detected
[3] Units for pH is standard pH units
[4] Units for Radon-222 is picocuries per liter
[5] Units for Specific Conductance is microhms per centimeter
[6] Comparison value if Cancer Risk Evaluation Guide (CREG)
[7] Comparison value is the primary drinking water standard for lead
[8] Comparison value is EPA Maximum Contaminant Level
[9] Comparison value is the EPA Lifetime Health Advisory
[10] Comparison value is EPA Secondary Drinking Water Standard
[11] Comparison value is a proposed standard of 300 picocuries per liter
[12] Comparison value is obtained from ATSDR Minimum Risk Level

A comparison can be made between the levels of chemicals found within the samples from private wells to levels of chemicals found within drinking water that are assumed to be safe levels of exposure. The Agency of Toxic Substances and Disease Registry (ATSDR) has determined and published a set of comparison values for substances that may be found in air, water, and soil. Comparison values (environmental guidelines) are measures of substance concentrations that are set well below levels that are known to cause, or anticipated to result in, adverse health effects. If a substance is found at the level of, or below the comparison value, it can be concluded that the presence of the substance will not cause adverse health effects.

Comparison values can also be obtained from the U.S. Environmental Protection Agency (EPA) standards for drinking water. Comparison values are not available for some of the chemicals found within water from the private wells since there is very limited toxicological information available for these chemicals, and are not included in the Table 1.

The levels of the chemicals measured in these private wells vary over time, but are generally below comparison values. The concentration of ten of the chemicals found to be present in water from the private wells is greater than the comparison values shown in Table 1 (previous pages). These substances, their concentrations, and corresponding comparison values are included in the following table.

Table 2 – Chemicals found to be present above Comparison Values in Private Well Water

Chemical Parameter	Concentration in Well Water (mg/l)	Comparison Value (mg/l) (2)
Arsenic, total	0.03	0.01
Benzene	0.030	0.005
Copper, total	0.127	0.1
bis(2-Ethylhexyl)phthalate	0.53	0.002
Lead, total	0.15	0.015
Manganese	1.38	0.3
Nitrate + Nitrite as NO_3	119	10
pH	6.4-9.1[1]	6.5-8.5[1]
Radon-222	699[2]	300[2]
Thallium	0.00103	0.0005
Trichloroethylene	0.0052	0.005

[1] Units for pH is standard pH units
[2] Units for Radon-222 is picocuries per liter. The proposed Maximum Contaminant Level for public water supplies serving more than 10,000 people.

Toxicological Evaluation

Exposure to chemicals found in the private wells either at or below comparison values will not adversely impact human health. However, in order to determine the potential for adverse health effects from exposure to the chemicals at levels above comparison values (those included in Table 2), it is necessary to look at additional toxicological information related to each of these chemicals. The following paragraphs discuss pertinent toxicological information related to exposure to each of the eleven chemicals found in the private wells that had monitored levels above comparison values.

Arsenic

Inorganic arsenic has been recognized as a human poison since ancient times. Large oral doses of arsenic, above 60,000 parts per billion (ppb) in food or water, can result in death. If a person swallows smaller doses of arsenic, 300 to 30,000 ppb in food or water, a person may experience irritation of the stomach and intestine, with symptoms such as stomachache, nausea, vomiting, and diarrhea. Other effects a person might experience from swallowing inorganic arsenic include decreased production of red and white blood cells, which may cause fatigue, abnormal heart rhythm, blood-vessel damage resulting in bruising, and impaired nerve function causing a "pins and needles" sensation in the hands and feet (3).

Perhaps the single-most characteristic effect of long-term oral exposure to inorganic arsenic is a pattern of skin changes. These include a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso, and are often associated with changes in the blood vessels of the skin. A small number of the corns may ultimately develop into skin cancer (3). Studies have been completed that have determined the lowest dose of arsenic where these pattern of skin changes begin to take place within individuals who were exposed to arsenic from drinking contaminated well water over many years.

The lowest dose of chronic arsenic exposure where skin changes were not observed was 0.0008 mg/kg/day (3). This dose is called the no observed adverse effect level or NOAEL. The lowest dose of chronic arsenic exposure where skin changes were observed was 0.0012 mg/kg/day. This dose is called the lowest observed adverse effect level or LOAEL.

The highest concentration of arsenic found in the water samples of the private wells in Clinton County must be converted to a dose in order to be compared to the NOAEL and the LOAEL. The highest concentration in the water samples can be converted to a dose by assuming that an average adult (weighing70 kg) consumes 2 liters (L) of water per day and by using the following equation:

$$30\ \mu g/L \times 1\ mg/1000\ \mu g \times 2L/day \times 1/70\ kg = 0.0009\ mg/kg/day$$

The highest dose at the concentration of arsenic found within the water samples within private wells is above the NOAEL dose but below the LOAEL dose.

Exposure to drinking water containing arsenic at certain levels can increase the risk of developing cancer. Epidemiological studies completed in Taiwan found that exposure to drinking water containing arsenic at concentrations ranging from 350 to 1,140 μg/L increased the risks of bladder, kidney, skin, lung, liver, and colon cancer (3). These concentrations are at least ten times higher than the highest level of arsenic found within the private wells.

Since the exposure dose at the highest concentration of arsenic found in the private wells is below the LOAEL and below the level of increased risks of bladder, kidney, skin, lung, liver, and colon cancer; and for the majority of the samples collected from the private wells, the concentration of arsenic in the water was even lower, it can be concluded that the risk of adverse health effects from exposure to arsenic in these private wells is minimal.

Benzene

Benzene is a naturally occurring substance that is found in petroleum and gasoline. Exposure to large amounts of benzene can cause problems in blood and in blood forming organs. Benzene is a known human carcinogen, but this has only been documented in cases where people were exposed to a significant amount of benzene in the air that they breathed.

The highest concentration of benzene found in water from the Clinton County private wells was 0.030 mg/l. A review of the sampling data and the analysis of that data indicate that benzene detections in the well water were rare. The concentration of benzene in the water from the private wells tested was below the detection laboratory level of 0.0005 mg/l during almost all of the time the private wells were sampled.

The comparison value of 0.005 mg/l is the primary drinking water standard for benzene. This drinking water standard for benzene has been set as close as possible to the U.S. EPA's health goal of zero. In setting their standards, EPA considers the ability of public water systems to detect and remove benzene using suitable treatment technologies, as well as the cost and benefits of doing so. The comparison value of 0.005 mg/l benzene in water is considered to be a level where no adverse health effect would be observed in individuals, even if an individual was exposed to this level over an entire lifetime.

The Toxicological Profile for Benzene, developed by ATSDR, includes information regarding the ingestion exposure to benzene (4). Within this toxicological profile are details of studies that were completed on individuals that were exposed to benzene in the workplace, and studies that were completed on laboratory animals.

ATSDR's toxicological profile also includes information on acute, or short time exposures (from 1 day to 14 days), intermediate exposures (14 days to one year), and chronic exposures (greater that one year). In addition, the toxicological profile includes information on the NOAEL and the LOAEL

In the case of oral exposure to benzene, the toxicological profile indicates that the LOAEL is determined to be a dose of 0.29 mg per kg of body weight per day of exposure. At this dose, reduced white blood cell and platelets counts were observed in workers who accidently ingested or swallowed 0.29 mg per kg of body weight of benzene per day.

We can determine the significance of the highest level of benzene found in the private wells (0.030 mg/l) by comparing it to the LOAEL of 0.29 mg per kg body weight per day. In order to compare a dose of 0.29 mg per kg body weight per day to consuming water that contains benzene at a concentration of 0.030 mg/l, it is necessary to make some assumptions about water consumption. If we assume that the average sized adult weighing 70 kg consumes 2 liters of water per day, we can calculate the dose of ingesting 0.030 mg/l benzene by the following equation:

$$0.030\ \frac{mg}{l} \times \frac{1}{70\ kg} \times \frac{2\ liters}{day} = 0.00086\ \frac{mg}{kg - day}$$

This calculated dose of 0.00086 mg per kg of body weight per day of exposure is 337 times lower than the LOAEL of 0.29 mg per kg body weight per day of exposure. This is a very low dose and we can conclude that the risk of non-carcinogenic adverse health effects from exposure to drinking water containing benzene at a concentration of 0.030 mg per liter will be very minimal, if any at all. Also, as discussed earlier, benzene was not detected in the majority of the private well samples, which lends additional support to the statement that there is no appreciable risk of adverse health effects from benzene found in these private wells.

Benzene is classified as a known carcinogen, and as a result a comparison value called a cancer risk evaluation guide (CREG) has been established. The CREG is the estimation, based on mathematical modeling, of the level of benzene in the drinking water that would produce a theoretical increased of one additional cancer case if one million people were exposed at this level over a lifetime. The CREG for benzene in water is 0.0006 mg per liter. Health and environmental agencies normally consider a theoretical increased of one additional cancer cases in ten thousand people to be an acceptable risk. The concentration of benzene in water that would equate to a theoretical increased risk of one additional cancer case in ten thousand people exposed to a level of 0.060 mg per liter. The highest measured benzene concentration in the private wells of 0.030 mg per liter does not pose an unacceptable risk for cancer.

Copper

Copper is an element that is found naturally in soil, water, and sediment. Exposure to large amounts of copper in drinking water can cause gastrointestinal disturbances in people. The comparison value for copper is 0.1 mg/l and is considered to be a level where no adverse health effect would be observed in individuals exposed to drinking water containing this concentration of copper. The comparison value of 0.1 mg/l is based upon the NOAEL for exposure to copper in drinking water, or 0.042 mg per kg of body weight per day of exposure, found in the Toxicological Profile for Copper (5). This NOAEL was determined based on a study of people exposed to copper in drinking water for a period of 2 months.

Let's compare the highest concentration of copper found in the private wells to the NOAEL discussed above. Again, if we assume that an individual weighing 70 kg drinks two liters of water a day, we can determine the dose of drinking 0.127 mg/l copper (the highest level found in the private wells) by the following equation:

$$0.127 \frac{mg}{l} \times \frac{1}{70\ kg} \times \frac{2\ liters}{day} = 0.0036 \frac{mg}{kg - day}$$

The calculated dose of 0.0036 mg per kg body weight per day of exposure is 11 times lower than the NOAEL of 0.042 mg per kg body weight per day of exposure. Due to this very low dose at the highest concentration of copper found in the private wells, and the fact that for the majority of the samples collected from the private wells, the concentration of copper in the water was even lower, it can be concluded that the risk of adverse health effects from exposure to copper in these private wells is minimal.

Bis(2-Ethylhexyl)phthalate

Bis(2-ethylhexyl)phthalate or di(2-ethylhexyl)phthalate (DEHP) is a manufactured chemical that is added to plastics to make them flexible. Exposure to DEHP at the levels normally found in the environment is not expected to cause adverse health effects. Exposure to high levels of DEHP by humans may cause abdominal pain and diarrhea. DEHP has been classified by the U.S. EPA as a probable human carcinogen. The comparison value of 0.002 mg/l is the level of exposure that corresponds to a theoretical one-in-one million risk of getting cancer, if a person has a lifetime exposure to DEHP in water at this concentration. This theoretical level is a mathematical estimate based upon studies completed on laboratory animals.

A NOAEL of 5.8 mg per kg of body weight per day of exposure is reported in the Toxicological Profile for Di(2-ethylhexyl)phthalate (6) and is based upon studies completed on laboratory animals. To compare the highest concentration of DEHP found in the private wells to the NOAEL, we need to determine the dose of drinking water containing 0.028 mg/l DEHP by the following equation:

$$0.028 \frac{mg}{l} \times \frac{1}{70\ kg} \times \frac{2\ liters}{day} = 0.0008 \frac{mg}{kg - day}$$

The dose of 0.0008 mg per kg of body weight per day of exposure is 446 times lower than the NOAEL of 5.8 mg per kg body weight per day of exposure. Due to this very low dose at the highest concentration of DEHP found in the private wells, and the fact that for the majority of the samples collected from the private wells the concentration of DEHP in the water was not detected by the laboratory, it can be concluded that the risk of non-carcinogenic adverse health effects from exposure to DEHP in these private wells is minimal.

DEHP is classified as reasonably anticipated to be a human carcinogen, and as a result a CREG has been established. The CREG for DEHP in water is 0.002 mg per liter. The concentration of DEHP in water that would equate to a theoretical increased risk of one additional cancer case in ten thousand people exposed is 0.2 mg per liter. The highest measured benzene concentration in the private wells of 0.028 mg per liter does not pose an unacceptable risk for cancer.

Lead

Lead is an element that can be found within drinking water if the water pipes in that home contain lead and the water is acidic (a pH lower than 7). Exposure to lead can affect the nervous system of both children and adults. For public water supplies, the comparison value of 0.015 mg/l is a level that triggers the need for additional water quality monitoring and possible corrosion control treatment (7). The highest level of lead detected in water from the private wells was 0.15 mg/l. For a majority of the samples collected from the private wells, lead was not detected, even in the private wells that periodically tested positive for lead.

Exposure to lead should be avoided, since low levels of exposure can adversely impact the health of children. The most likely source of lead in drinking water is from older water pipes within the home that contains lead solder. The Toxicological Profile for Lead (8) recommends that if lead is detected in drinking water, the water should be run for some time prior to use in order to flush out any lead that might be present in the piping. In addition, older metal pipes should be replaced to limit exposure to lead.

For those homes that had detectable quantities of lead in the private wells, the recommendation is to flush pipes that have not been used in the last 6 hours by running the water until it comes out cold to the touch (5 seconds to 2 minutes). Because lead dissolves more easily in warm water than in cold water, only cold water should be used for drinking, cooking, and preparing baby formula.

Manganese

Manganese is present in soil at levels that average almost 1,500 milligram per kilogram (mg/kg) or 1,500 parts per million (ppm). Manganese is a normal part of living things, including both plants and animals, so it is present in many foods that we eat. For nearly all people, food is the main source of manganese, and usual daily intakes range from about 1 to 10 mg/day. Assuming a body weight of 70 kg, this usual daily intake would range from 0.014 to 0.14 mg/kg/day.

The comparison value for manganese is the lifetime health advisory level of 0.3 mg/l developed by the U.S. Environmental Protection Agency. Manganese is an essential nutrient in small amounts and there is limited information on adverse health effects from exposure to large amounts of manganese. The Toxicological Profile for Manganese (9) indicates a LOAEL of 0.059 mg per kg of body weight per day of exposure. This LOAEL was determined by recognizing how humans, exposed to this dose for 50 years, experienced mild neurological symptoms

Let's compare the highest concentration of manganese found in the private wells to the LOAEL discussed in the previous paragraph. Using the standard exposure assumptions, the dose of drinking 1.38 mg/l manganese is determined by the following equation:

$$1.38\ \frac{\text{mg}}{\text{l}} \times \frac{1}{70\ \text{kg}} \times \frac{2\ \text{liters}}{\text{day}} = 0.039\ \frac{\text{mg}}{\text{kg - day}}$$

The dose of 0.039 mg per kg per day is below the LOAEL and is also within the normal range of exposure to manganese from food. It can be concluded that the additional risk of adverse health effects from exposure to manganese in these private wells is minimal.

Nitrate and Nitrite

A source of nitrate and nitrite in private wells is nitrogen-based fertilizers. Nitrates themselves are relatively nontoxic. When swallowed, nitrates are converted to the more toxic nitrites and can react with hemoglobin in the blood, to form methemoglobin. Methemoglobin prevents the blood from carrying oxygen through the body, creating a condition known as methemoglobinemia. Infants younger than 4 months of age are most susceptible to developing methemoglobinemia, because the acid level (pH) of their gut is normally higher than in older children and adults. The higher pH causes nitrate to change more quickly to nitrite. There is a potential for infants to develop methemoglobinemia, also known as blue baby syndrome, when the concentration of nitrate in drinking water is above 10 mg/l, or the concentration of nitrite in drinking water is above 1 mg/l.

The highest concentration of the combination of nitrate and nitrite found in the private wells is 119 mg/l. At this level there is a risk of adverse health effects to infants who may be consuming the drinking water. During the years this data was collected, the levels of nitrate and nitrate found in the private wells were found to be consistently over the 10 mg/l level. At times, the levels of nitrate and nitrate were approaching or exceeding the 100 mg/l level. At these levels of nitrate and nitrite, there is a risk of adverse health effects to infants consuming the drinking water. Water from these private wells should not be consumed by infants and bottled water should be used for mixing infant formula.

pH

pH is a measure of the concentration of the hydrogen ion within the water. It is a measure of whether the water is acidic or basic. A pH of 7 is neutral, that is, it is neither acidic nor basic. A pH lower than 7 is acidic and a pH of greater than 7 is basic. U.S. EPA has established secondary drinking water regulations as guidelines to assist public water systems in managing their drinking water for taste, color and odor. The secondary drinking water regulation for pH is represented by an acceptable range of pH values between 6.5 and 8.5. Contaminants are not considered to present a risk to human health at the level of these standards (10).

Although there are no health risks due to a pH of less than 6.5 or greater than 8.5 in drinking water, there may be some noticeable effects. At a pH level of 6.5 or less, water may have a bitter metallic taste and pipes can become corroded. At a pH level of 8.5 or greater, water can taste like soda and deposits can form inside pipes. It is recommended that the pH of each private well be monitored and adjusted to be within the 6.5 to 8.5 range, if needed.

Radon-222

Radon is a naturally-occurring radioactive gas that may cause cancer, and may be found in drinking water and indoor air. Some people who are exposed to radon in drinking water may have increased risk of getting cancer over the course of their lifetime, especially lung cancer. Radon released to indoor air from soil under homes and buildings is the main source of exposure and radon released from tap water is a much smaller source of radon in indoor air. According to the U.S. EPA radon in soil under homes presents a greater risk of lung cancer than radon in drinking water (11). The standard of 300 picocuries per liter (pCi/L) is part of a proposed regulation of the U.S. EPA. This proposed standard indicates that if public water supplies provide water at a level at or below 300 pCi/L, then additional mitigation to lower radon levels are not required (11).

Although some of the radon-222 levels in the private wells were over the level (300 pCi/L), it is felt that the risk of adverse health impacts from exposure to radon within drinking water is minimal when compared to the impact of radon that may be present within the indoor air of the homes having soil as its source. The amount of radon in the air within a home coming from the source of drinking water can be lowered if a holding tank is utilized that would allow for radon to decay prior to entering the home, or the drinking water is aerated prior to entering the home to remove any radon. For all homes that remain connected to a private well, it is recommended that a pressure tank be installed to reduce the potential of radon exposure.

The only way to determine if radon levels within a home are elevated is to conduct a radon test. A radon test is inexpensive and can be easily conducted. It is recommended that the indoor air of all homes within Iowa be tested for radon gas since radon levels within home vary throughout the state and can, in many instances, be above the level that the U.S. EPA recognizes needing remediation.

Thallium

Thallium is a metal that is widely distributed within the earth's crust. It can be found as a pure substance or combined with other elements to make compounds that contain thallium. If large amounts of thallium are eaten or swallowed, the nervous system, lungs, heart, liver, and kidneys can be affected.

The comparison value of 0.0005 mg/l is the lifetime health advisory level developed by the U.S. EPA. Although there is limited information in the Toxicological Profile for Thallium (12), the profile does indicate that the NOAEL for oral exposure to thallium is 0.2 mg per kg body weight per day of exposure. This NOAEL was determined from a 90 day study of rats. We can compare the highest concentration of thallium found in the private wells to the NOAEL. Using the standard exposure assumptions, the dose of drinking 0.00103 mg/l thallium is determines by the following equation:

$$0.00103 \ \frac{\text{mg}}{\text{l}} \times \frac{1}{70 \text{ kg}} \times \frac{2 \text{ liters}}{\text{day}} = 0.000029 \ \frac{\text{mg}}{\text{kg - day}}$$

This dose is 10,000 times less than the NOAEL found in the Toxicological Profile for Thallium. From this, it can be concluded that the risk of adverse health effects from exposure to thallium in these private wells is minimal.

Trichloroethylene

Trichloroethylene is used as a solvent to remove grease from metal parts and to make other chemicals. Exposure to higher levels of trichloroethylene can cause liver damage. It is uncertain whether people who breathe air or drink water that contains trichloroethylene are at higher risk of getting cancer, or of having reproductive effects, but some studies seem to indicate this.

There is a significant amount of data on the health effects of exposure to trichloroethylene as described in the Toxicological Profile for Trichloroethylene (13). Much of the information has been obtained from high dose studies on animals, or exposures to high doses in the workplace. Little information is known about the health impacts of low-level environmental exposures.

The highest level of trichloroethylene found in the private wells was 0.0052 mg/l, which is just over the U.S. EPA maximum contaminant level of 0.005 mg/l. The U.S. EPA utilizes safety factor when setting maximum contaminant levels (MCL) for drinking water and are generally 10 times higher than the level considered to be safe. Since trichloroethylene was detected in the majority of the private wells at levels below the U.S EPA maximum contaminant levels, it can be concluded that the risk of adverse health effects from exposure to trichloroethylene in these private wells is minimal.

Childhood Health Concerns

Children have unique vulnerabilities to some environmental chemicals and the Iowa Department of Public Health evaluated the potential impact of the presence of the chemicals detected within the private wells in the area of Clinton County west of Highway 67 and Camanche on children's health. In most cases the dose of exposure to the chemicals found within the drinking water are significantly below the levels that have been seen to have an impact to human health including children.

Since the exposure to lead is of particularly of concern to the health of children, special recommendations are being made to homes that have children. These recommendations are summarized in the following paragraphs.

Summary and Conclusion

From the early 1990s to the present, private wells in the area west of Highway 67 and Camanche, Iowa have been tested for the presence of a total of 75 chemicals at various times. We compared the levels of chemicals found in these private wells to their comparison values, or to the levels where no adverse health impacts are expected. In addition, we reviewed available toxicological information for each of these chemicals to determine the potential for adverse health impacts from drinking the private well water. In addition, we evaluated the significant effects on health for the chemicals that were detected at concentrations above comparison values, including: arsenic, benzene, copper, bis(2-ethylhexyl)phthalate, lead, manganese, nitrate and nitrite, pH, radon-222, thallium, and trichloroethylene.

Exposure to most of the chemicals detected in the private wells, even at the highest levels these chemicals were detected, is not expected to harm people's health. However, nitrate and nitrite found within the private wells have been routinely detected at levels significantly above drinking water standards and could harm the health of infants who may be consuming water from the private wells.

Recommendations

For those homes that had detectable quantities of lead or copper within the private wells, the Iowa Department of Public Health recommends that anytime water in a faucet has not been use for 6 hours or longer, the cold water pipes should be flushed by running water until it is cold to touch (5 seconds to 2 minutes). Since lead dissolves more easily in warm water, the Iowa Department of Public Health recommends that only cold water should be used for drinking and cooking for homes that have older metal plumbing. The Iowa Department of Public Health also recommends that water from the private wells should not be consumed by infants due to the nitrate/nitrite levels found in the water. Bottled water should be used for mixing infant formula. Finally, the Iowa Department of Public Health recommends that a pressure tank be installed in all homes that remain connected to a private well to reduce the potential of radon exposure.

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Sincerely,

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