# Health Consultation

Limited Private Well and Soil Assessment

ROCK ISLAND AREA

ROCK ISLAND, DOUGLAS COUNTY, WASHINGTON

**Prepared by**
**Washington State Department of Health**

JUNE 30, 2015

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

**Health Consultation: A Note of Explanation**

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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# Foreword

The Washington State Department of Health (DOH) prepared this health consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services. ATSDR is responsible for health issues related to hazardous substances.

The purpose of a health consultation is to assess the health threat posed by hazardous substances in the environment. If needed, a health consultation will also recommend steps or actions to protect public health. Health consultations are initiated in response to health concerns raised by residents or agencies about exposure to hazardous substances.

This health consultation was prepared in accordance with ATSDR methodologies and guidelines. ATSDR has reviewed this document and concurs with its findings based on the information presented. The findings in this report are relevant to conditions at the site during the time the report was written. It should not be relied upon if site conditions or land use changes in the future.

Use of trade names is for identification only and does not imply endorsement by state or federal health agencies.

For additional information, please contact us at 1-877-485-7316 or visit our web site at www.doh.wa.gov/consults.

For persons with disabilities this document is available on request in other formats. To submit a request, please call 1-800-525-0127 (TDD/TTY call 711).

For more information about ATSDR, contact the CDC Information Center at 1-800-CDC-INFO (1-800-232-4636) or visit the agency's web site at www.atsdr.cdc.gov.

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# Summary

## Introduction

The Washington State Department of Health (DOH) conducted this health consultation at the request of the U.S. Environmental Protection Agency (EPA). The purpose of the health consultation is to assess the potential health threat posed by contaminants found by EPA in the Rock Island area in July 2011. The contaminants were found in water from three private wells and some shallow soil. EPA conducted the testing after receiving a petition from a family concerned about the source of arsenic found in their well.

DOH determined the following regarding water from the three private domestic wells and soil:

## Private Domestic Wells

### Conclusion 1

Water from the three private domestic wells could harm people's health if used for drinking or food preparation. Food preparation includes washing foods, cooking, or using well water as an ingredient.

### Basis for Decision

- ***Orchard Well***: The level of arsenic found in water from this well could result in an increased lifetime risk of developing cancer if used for drinking or food preparation. Non-cancer health effects are also possible. The levels of sodium found in this well could be a health concern for individuals on a 500 mg/day restricted sodium diet.

- ***Field Well***: The level of arsenic found in this well could result in an increased lifetime risk of developing cancer if used for drinking or food preparation. Non-cancer health effects are also possible. Non-cancer health effects are not expected for adults. However, non-cancer health effects may be possible for children from birth to less than 6 years who drink or eat foods prepared with more than average amounts of water. Non-cancer health effects are also possible for children from birth to < 1 year who drink or eat foods prepared with average amounts of water.

- ***Yard Well***: The level of arsenic found in this well could result in an increased lifetime risk of developing cancer if used for drinking or food preparation. Non-cancer health effects are not expected for adults or children.

### Conclusion 2

Water from the three private domestic wells does not pose a health threat if used for bathing and cleaning.

## Basis for Decision

Arsenic in water is poorly absorbed through the skin so dermal exposure is not a concern unless levels are very high. Arsenic found in the three private wells, while elevated, is not considered high. Arsenic does not readily evaporate from water so inhalation exposure is also not a concern.

## Recommendations

- Test private well water periodically[a] to evaluate the safety of the water supply. Because contaminant levels can vary seasonally, DOH recommends testing for arsenic and other contaminants in late summer and in the early spring to see if there are differences.

- Consider the following options for reducing exposure to arsenic: bottled water, an alternate water supply, or install arsenic treatment.[b]

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# Soil

## Conclusion

Limited soil sampling found potentially harmful levels of lead and arsenic. However, DOH cannot evaluate the likelihood of harm of without further information about the extent and magnitude of the contamination.

## Basis for Decision

There are not enough soil data to conduct a health assessment. However, if levels of arsenic and lead similar to those found at the cherry orchard or near the former silicon plant are present across those properties and people are exposed, there is a health risk.

## Recommendations

Further soil testing should be considered at the cherry orchard property and property near the former silicon plant. Until then, it is recommended that property owners take the following steps as a precaution:

- Wash hands and face with soap and water after working or playing outside and before eating.
- Prevent soil from being tracked inside:
    - Cover bare soils where children or pets play with grass, bark, gravel, or clean soils.
    - Use doormats at each door.
    - Take off shoes when coming inside.

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[a] The Washington State Department of Health recommends that private well users test their well water every year for coliform bacteria and nitrate.(1)

[b] DOH's has additional information and recommendations about arsenic and private wells on its website: http://www.doh.wa.gov/Portals/1/Documents/Pubs/334-156.pdf. A copy of that information is also provided in Appendix B.

    - Wipe/wash pet paws when animals come inside.
- Mop, dust, and vacuum:
    - Damp mop or damp dust floors, windowsills, bookcases, and other surfaces at least once a week.
    - Vacuum carpets and upholstered furniture at least once a week.
    - Use a vacuum cleaner with a filter that captures dust such as a High Efficiency Particulate Arrestor (HEPA) filter.
- Minimize dust during dry weather by watering exposed soils in gardens and play areas where soil may become airborne.

When testing soil in the future, DOH recommends using analytical methods that are sensitive enough to determine whether the tested contaminants are present above or below their respective health comparison values.

## Next Steps

DOH will prepare a health consultation addressing the arsenic results from the other Rock Island area private wells tested in 2012. The report is anticipated to be completed in 2014.

## For More Information

If you have any questions about this health consultation contact the Washington State Department of Health at 1-877-485-7316. A copy of this health consultation will be available on the DOH webpage at http://www.doh.wa.gov/consults.

For more information about ATSDR, contact the Center for Disease Control and Prevention (CDC) Information Center at 1-800-CDC-INFO (1-800-232-4636) or visit the agency's web site at www.atsdr.cdc.gov.

# Purpose and Statement of Issues

The Washington State Department of Health (DOH) conducted this health consultation at the request of the U.S. Environmental Protection Agency (EPA). The purpose of the health consultation is to assess the potential health threat posed by contaminants found by EPA in the Rock Island area in July 2011. The contaminants were found in water from three private wells and some shallow soil. EPA conducted the testing after receiving a petition from a family concerned about the source of arsenic found in their well. DOH conducts health consultations under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

# Background

### Site Description

The city of Rock Island is located north of the Columbia River in Douglas County, Washington (Figure 1). Homes and businesses within the city limits, as well as a few outside, receive their drinking water from the city of Rock Island public water system (e-mail communication between Barbara Trejo, DOH and David Prosch, Chelan-Douglas Health District, April 16, 2012). Other homes and business outside the city limits receive their drinking water from private wells. Arsenic has been found in a few wells in the Rock Island area.(2)

Orchard lands are located throughout the Rock Island area. Historically, pesticides have been applied to orchard lands across Washington.

### Geology/Hydrogeology

Shallow soils within the Rock Island area typically consist of sands and gravels. A thick sequence of basalt flows and interbedded sediments associated with the Columbia River Basalt Group (CRBG) is found below the shallow soils. Older rock types underlie the CRBG.(2)

Groundwater found in the sands and gravels is generally shallow and unconfined. This makes it susceptible to contamination. Sources of contamination include rainwater, irrigation water, and water from septic systems. Although vulnerable to contamination, a number of private wells in the Rock Island area draw their water from the shallow aquifer. Other private wells in the area draw water from the CRBG. Rainfall and the overlying shallow sand and gravel aquifer are two sources of water that recharge the CRBG.(2)

### Environmental Investigations

EPA tested three private domestic wells in July 2011. One of those wells was the petitioner's. They also tested shallow soil or sediment at a few locations.[c]

[c] Additionally, EPA conducted a preliminary assessment and a site investigation at the former Rock Island Silicon Plant, which is located in the southern portion of the Rock Island area, because of the petitioner's concern that this facility may be a possible source of arsenic. EPA's preliminary assessment report was released April 2012.(3) EPA

Water samples were collected from the three domestic wells as follows:

- GW-1 and a duplicate sample (DP), GW-2 were collected from an outdoor tap associated with a well located in a cherry orchard.[d]
- One water sample (GW-3) was collected from a pressure tank associated with a well located near an open field.
- One water sample (GW-4) was collected from an outdoor tap associated with a well located in a residential yard.(5)

Approximate well locations are shown on Figure 2. No information about well depths or construction details is available for these three wells.

Soil and sediment samples were collected at the following locations:

- Two background soil samples were collected along a right-of-way located approximately five miles west of Rock Island. One sample was collected from 0 to 6-inches below ground surface (bgs) (BG-1). The second sample was collected at the same location from 3 to 3.5 feet bgs (BG-2).[e]
- Three soil samples were collected near the well located in the cherry orchard. One sample and a field duplicate were collected from 0 to 6- inches bgs (SS-1and SS-1(DUP)). The second sample was collected at the same location from 3 to 3.5 feet bgs (SS-2).
- One soil sample was collected from 0 to 6-inches bgs (SS-3) east of the former silicon plant property south of Highway 28.
- One sediment sample was collected at a freshwater pond east of the silicon plant property and south of Highway 28 from 0 to 6-inches bgs (SD-1).(5)

Approximate soil and sediment locations are shown on Figure 2.

The sediment sample from the freshwater pond and soil sample south of Highway 28 were collected to assess the potential impact of the former Rock Island Silicon Plant. EPA reported that it seemed unlikely that people would be exposed to the soil and sediment because it was near the railroad track (e-mail communication between Barbara Trejo, DOH and Kathy Parker, EPA, April 19, 2012).

The soil, sediment, and well water were tested for total metals including arsenic using EPA Method 6010/6020. They were also tested for organochloride pesticides using EPA Method 8081. Tables 1 and 2 contain the private well results for metals and pesticides, respectively; Tables 3 and 4 contain the soil and sediment results for metals and pesticides, respectively.(5)

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completed a site investigation at the former plant in April 2013, concluding that the former plant was unlikely to be the source of the arsenic found in the petitioner's well.(4)

[d] EPA report no one was drinking, or cooking with the water from this well (e-mail communication between Barbara Trejo, DOH, and Kathy Parker, EPA, April 19, 2012).

[e] Because these samples do not appear to represent natural background conditions (i.e. conditions unaffected by human activities) in the area, the results were not used by EPA, or DOH, for background comparisons.

As shown in Tables 1 and 3, metals were found in all the soil, sediment, and well water samples collected by EPA. No pesticides were found in the well water samples above the laboratory reporting levels (Table 2). However, two pesticides (4,4'-dichlorodiphenyldichloroethylene (4,4'-DDE) and 4,4'-dichlorodiphenyltrichloroethane (4,4'-DDT) were found at low levels in the sediment and soil samples. The pesticide 4,4'-dichlorodiphenyldichloroethane (4,4'-DDD) was also found at low levels in a couple of soil samples (Table 4).

DOH was contacted by ATSDR in July 2011 about the EPA private well arsenic results. At that time, DOH recommended that ATSDR provide EPA with a copy of the DOH brochure *Arsenic and Your Private Well*. The brochure provides an explanation about arsenic testing, what arsenic testing results mean relative to human health, and steps well owners can take to reduce their exposure to arsenic. EPA provided copies of the brochure to the well owners (e-mail communication between Barbara Trejo, DOH and Kathy Parker, EPA, August 10, 2011). The brochure has since been updated. A copy of the update brochure is included in Appendix B.

# Community Health Concerns

Some private well owners are concerned their wells contain arsenic at levels of health concern. A family, who had previously found arsenic in their well, petitioned EPA in June 2011 to investigate the potential source.

# Discussion

Contaminants were found in soil, sediment, and the three private drinking water well samples tested by EPA in July 2011. Exposure to these contaminants can occur through:

- Ingestion (drinking contaminated groundwater or eating contaminated soil or sediment),
- Inhalation (breathing in contaminants that evaporate from soil, sediment, and groundwater or are attached to dust particles), and
- Dermal contact (skin contact with contaminated soil, sediment, or groundwater).

Exposures could occur over a lifetime if residents used the water daily for drinking, cooking, or showering and bathing or are in daily contact with contaminated soil.

**Exposure Pathway Evaluation**

To begin assessing the possible health threat posed by these contaminants, an exposure pathway evaluation was conducted. An exposure pathway evaluation helps us determine ways in which people might come into contact with the contaminants. An exposure pathway is the route a contaminant takes from where it began (source) to where it ends, and how people can come into contact with it. An exposure pathway has five parts:

- Source of contamination (such as a rock containing arsenic);
- Environmental media and transport mechanism (such as movement of a dissolved contaminant through groundwater);

- Point of exposure (such as a private well);
- Route of exposure (eating, drinking, breathing, or touching); and
- Receptor population (people potentially or actually exposed).

When all five parts are present, the exposure pathway is considered a completed exposure pathway. A potential exposures pathway exists if one or more parts of the exposure pathway are missing.

There are many factors that determine if an exposure will cause health effects. These factors include:

- Dose (how much),
- Duration (how long), and
- How someone comes in contact with the contaminants (touching, ingesting, or breathing in the contaminant).

A person's age and the number of contaminants they are exposed to are a few other factors that may determine if exposure will cause health effects.

*Private Wells*

The three wells tested by EPA are being used for domestic purposes. As a result, a completed exposure pathway exists for residents and visitors. The well located in the orchard is currently only being used for food washing and showering and bathing. No one is drinking or using the water for food preparation (e-mail communication between Barbara Trejo, DOH and Kathy Parker, EPA, April 19, 2012). However, in the past, the well had also been used for drinking and cooking. At the time of EPA's testing, water from the other two private wells was being used for drinking, food preparation, and bathing and showering. Ingestion, dermal contact, and breathing in contaminants found in the water are the primary ways people could be exposed to the contaminants found in the three wells.

*Soil/Sediment*

A potential exposure pathway exists for the tested soil and sediment. It is uncertain whether ingestion, dermal contact, or inhalation of contaminated soil could be occurring at the tested properties. This is because testing was limited to only one surface sample (0-0.5 feet) at each property. While this testing gives some limited indication about possible contaminant levels in soil at these locations, the data may not represent the levels found across the individual properties.

**Contaminants of Concern and Health Effects Evaluation**

To identify contaminants that might be of health concern, DOH compared the level of each contaminant to health comparison values. *Health comparison values are levels of contaminants that are unlikely to cause people to get sick. This is done to be protective of the most sensitive individuals (i.e., children and older adults). It is also done to account for our lack of certainty regarding the adverse health effects of low levels of contaminant exposure.* When a contaminant

was noted as below a reporting limit[f], DOH used the reporting limit when comparing the contaminant to the health comparison values.

The primary water and soil health comparison values used by DOH were ATSDR's cancer risk evaluation guides (CREGs), environmental media evaluation guides (EMEGs), and reference dose media evaluation guides (RMEGs).(6) If no ATSDR health comparison values were available, DOH used federal and state drinking water standards (i.e., maximum contaminant levels (MCLs))[g], EPA regional screening levels for soil and water, or Washington Department of Ecology (Ecology) Model Toxics Control Act (MTCA) Method A cleanup levels.

If a contaminant was present but did not exceed the health comparison value, no further evaluation of that contaminant was necessary. This is because DOH does not expect those contaminants will pose a health threat. No further evaluation was also necessary if the contaminant was undetected in either water or soil samples and not expected to be present in the area. When a contaminant is found to be above a health comparison value, or no health comparison is available, further evaluation of that contaminant is needed. However, just because a contaminant was found above the comparison value does not necessarily mean that people will get sick if they are exposed.

*Private Wells*

Only two contaminants (arsenic and sodium) found in the well water exceeds the health comparison values (see Tables 1 and 2). Sodium is a common mineral found in water. Three of the contaminants (calcium, magnesium, and potassium), which are also common minerals found in water, had no comparison value. These five contaminants were evaluated further.

Six contaminants aldrin, alpha-BHC, dieldren, heptachlor, heptachlor epoxide, and toxaphene were tested for but not detected at the three private wells. However, the analytical method for these six contaminants was not sensitive enough to determine whether they might be present above or below their respective health comparison values. As a result, these contaminants cannot be further assessed at this time.

Arsenic

Arsenic is a naturally occurring contaminant that is found in soil, water, air, food, and house dust. In the past, arsenic was used to treat wood and was also used as a pesticide in orchards. It has also been added in small amounts to other metals to form alloys with improved properties.(9)

Drinking water in Washington typically contains about 3 µg/l arsenic. However, higher levels of arsenic have been found in some areas in Washington including the Rock Island area(10). Those elevated levels are usually associated with water located in rock or soil that has a naturally high

[f] Reporting limits are the lowest concentration at which a chemical can be detected in a sample and its concentration can be reported with a reasonable degree of accuracy and precision.

[g] Federal and state drinking water standards are found in the Safe Drinking Water Act and Washington Administrative Code 246-290, respectively. These drinking water standards are intended to protect the health of people on public water systems(7;8)

amount of arsenic.(11) However, in eastern Washington, including the Rock Island area, some of the elevated arsenic levels found in groundwater might be associated with historic use of lead arsenate in orchard lands.(2)

The primary way people are exposed to arsenic is by drinking or preparing food with water containing arsenic.(9) Arsenic in water is poorly absorbed through the skin so dermal exposure is not a concern unless levels are very high. Arsenic does not readily evaporate from water so inhalation exposure is also not a concern.

Long-term exposure to small amounts of arsenic can increase the risk of developing cancer of the bladder, lung, skin, liver, kidney, or prostate. Other health effects may include high blood pressure, narrowing of the blood vessels, nerve damage, anemia, diabetes, stomach upset, and skin changes. However, it is difficult to predict whether arsenic in drinking water will affect a particular individual, or what the effects will be.(12)

To evaluate the health threat posed by the ingestion of arsenic found in the three private wells[h], the health department calculated doses for specified age ranges using average and reasonable maximum exposure (RME) (approximately 95th percentile) ingestion rates. The doses were then used to evaluate whether cancer or non-cancer health effects associated with the levels found in well water were possible. The equation used for calculating doses along with the associated input parameters are summarized in Appendix C.

## Evaluating Non-Cancer Health Effects Associated with Arsenic

The exposure dose for a range of ages were then compared to ATSDR's arsenic acute oral minimal risk level (MRL) of 5E-03 mg/kg-day and chronic oral MRL of 3.0E-04 mg/kg-day) to determine whether the arsenic in the water could pose a potential non-cancer health threat if the well water was ingested (Table 5) [i]. An ATSDR MRL is an estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous health effects. MRLs, however, are not used as predictors of harmful (adverse) health effects. When doses exceed the MRLs, additional evaluation is done by comparing the doses to the appropriate LOAELs or NOAELs to determine if non-cancer health effects are possible (Table 6).

[h] The results from the samples collected in the orchard (sample (GW-1) and duplicate (GW-2)) were averaged (116 µg/l).

[i] ATSDR's chronic oral MRL (0.0003 mg/kg-day) is based on a no observed adverse effect levels (NOAEL) of 0.0008 mg/kg-day divided by an uncertainty factor of 3. A NOAEL is the highest tested dose of a substance that has been reported to have no harmful health effects on people or animals. The acute oral MRL (0.005 mg/kg-day) is based on a lowest observed adverse effect levels (LOAEL) of 0.05 mg/kg-day divided by 10. The LOAEL is the lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

## Evaluating Cancer Effects associated with Arsenic

Some contaminants like arsenic have the ability to increase people's risk of developing cancer. Because current risk assessment practice assumes there is no "safe dose" of a carcinogen, any dose of a carcinogen will result in some additional increased cancer risk. Cancer risk estimates are not yes/no answers but measures of chance (probability). Such measures, however uncertain, are useful in determining the magnitude of a cancer threat.

Cancer is a common illness and its occurrence in a population increases with the age of the population. There are many different forms of cancer resulting from a variety of causes; not all are fatal. Approximately 1 in 3 to 1 in 2 people living in the United States will develop cancer at some point in their lives.(13)

Cancer risk that is attributable to site-related contaminants can be described in quantitative and qualitative terms by considering the population size required for such an estimate to result in a single cancer case. Contaminants are considered to pose an increased cancer risk when the estimated cancer risk is greater than or equal to one additional cancer case per ten thousand persons exposed over a lifetime (>= 1E-04). One additional cancer cases per million persons exposed over a lifetime to nine additional cancer cases per hundred thousand persons exposed over a lifetime (1E-06 to 9E-05) is considered a low cancer risk. A cancer risk is considered insignificant or indiscernible from background when the cancer risk estimate is less than one additional cancer per one million persons exposed over a lifetime (<1E-06).

The calculated doses were used to estimate cancer risk levels using the cancer slope factor of 5.7 mg/kg-day$^{-1}$currently used by the health department[j] (Table 7). The equation for calculating cancer risk along with associated input parameters is provided in Appendix C. Table 8 summarizes the estimated lifetime cancer risk levels from drinking water with arsenic found in the three wells.

The following summarizes the estimated lifetime cancer risk and a possibility of non-cancer health effects if water from each of the private wells is ingested at an average and RME dose:

- Orchard well
    - Lifetime estimated cancer risk ranges from 1 to 2 additional cancers in a population of 100 people, which is considered an increased risk.
    - Chronic non-cancer health effects are estimated to be possible for adults and children.

- Field well
    - 2 to 4 additional cancers in a population of 1,000 people, which is considered an increased risk.

[j] The 5.7 mg/kg-day$^{-1}$ slope factor currently being used by the health department is based on EPA's Science Advisory Board's 2005 report for bladder and lung cancer combined.(14)

    - Non-cancer health effects are estimated to be possible for children from birth to less than 6 years who drink water at the 95 percentile level and birth to < 1 year for children who drink an average amount of water.

- Yard well
    - 2 to 6 additional cancer in a population of 10,000 people which is considered an increased cancer risk.
    - Non-cancer health effects are not expected for children or adults who drink water from this well.

It is possible that exposure to arsenic can cause serious health problems for some people, but may have no effect on others. It's also possible for two people with similar exposures to develop different health problems. *However, more exposure to arsenic increases the likelihood that health problems could occur. Reducing exposure to arsenic reduces the risk.*

Sodium

Sodium was only detected above the sodium health comparison value (20,000 µg/l ) at the private well in the cherry orchard. (21,400 µg/l in sample GW-1 and 20,900 µg/l in the duplicate sample GW-2). In Washington, sodium in groundwater has been measured from 1,600 to 10,500,000 µg/l.(15)

Sodium is a naturally occurring element. The general public can be exposed to sodium in soil, water, air, food, and dust that contain sodium compounds. Food is the main source of daily human exposure to sodium, primarily in the form of sodium chloride (commonly known as salt). Much of the sodium found in our diets is added to food during processing.(16) Sodium in water could pose a health threat if large amounts are ingested. However, it is not expected to pose a health threat through skin contact or through inhalation.

Eating sodium is not expected to cause cancer. However, there have been some studies that suggest sodium chloride may increase cancer risk caused by other chemicals in the gastrointestinal tract.(17) Evidence suggests that high sodium diets can affect blood pressure.(16)

EPA assumes that an adult drinks about 2 liters of water per day (l/day) while a child drinks about 1 l/day. When considering the highest level of sodium found by EPA during the private well testing (21,400 µg/l or 21.4 milligrams per liter (mg/l)), this would result in the daily intake from tap water of 42.8 mg/day for an adult and 21.4 mg/day for a child.

In 2003, EPA developed a drinking water advisory level for sodium (20,000 µg/l or 20 mg/l of sodium for individuals on a 500 mg/day restricted sodium diet).(18) This EPA advisory level is based on a 1965 American Heart Association (AHA) recommendation and is intended to provide guidance to communities that may be exposed to drinking water containing sodium chloride or other sodium salts.(18;19) The EPA advisory also recommends reducing sodium concentrations in drinking water to between 30 mg/l and 60 mg/l, which most people would not consider salty tasting.(19) An EPA drinking water advisory levels is not a legally enforceable standard but does describe a non-regulatory level of a contaminant in water that is expected to be without adverse effects on both health and esthetics.(20)

In 2010, the U.S. Department of Agriculture (USDA) and the U.S. Department of Health and Human Services (USDHHS) released dietary guidelines for Americans ages 2 years and older. The two agencies recommended people reduce sodium intake to less than 2,300 mg/day. For persons who are 51 and older and those of any age who are African American or have hypertension, diabetes, or chronic kidney disease, it is recommended to further reduce intake to 1,500 mg/day.(16)

As a result of these recommendations, DOH does not consider the sodium levels found in the orchard well in July 2011 to pose a health threat to people 2 years or older. However, based on the levels found at GW-1/GW-2, consuming 2 liters of water per day would contribute slightly more than 40 milligrams of sodium to the daily intake. This might pose a very small health concern for someone on a 500 mg/day sodium restricted diet. It should be kept in the mind that there could be seasonal variations in sodium levels in these private wells.

The National Academy of Sciences (NAS) indicates there is a lack of data regarding sodium needs for infants and children. However, they did find some animal studies indicating that sodium is required for normal growth in neonatal rats. The NAS found no studies that evaluated how sodium levels affect growth or other effects in normal, full-term human infants.(17) This probably accounts for the lack of USDA and USDHHS recommendations for children less than 2 years. ***Families who may be concerned about sodium levels for children under 2 years should consider discussing their child's sodium needs with their pediatricians.***

Calcium

Calcium was detected at all three tested private wells. The highest calcium levels were found in the well located in the cherry orchard (99,900 µg/l in sample GW-1 and 97,800 µg/l in the duplicate sample GW-2). The well located near the open field (GW-3) contained 63,300 µg/l of calcium. The well located in the residential yard (GW-4) contained 47,900 µg/l of calcium. The calcium levels found in these three wells are all within the range found in Washington (12,000 to 5,140,000 µg/l).(15)

Calcium is a naturally occurring element. The general public can be exposed to calcium in soil, water, air, food, and dust that contain calcium compounds. Calcium in water could pose a health threat if large amounts are ingested. However, it is not expected to pose a health threat through skin contact or through inhalation. Adequate levels of calcium are necessary for good health. Generally, individuals are protected from excess intakes of calcium by a form of vitamin D. The excess is excreted by the kidney in most healthy people. However, there are concerns about excess calcium intake for individuals who are propone to milk alkali syndrome and hypercalcaemia (level of calcium in the blood is above normal).(21)

EPA estimates that an adult drinks about 2 liters of water per day (l/day) while a child drinks about 1 l/day. When considering the highest level of calcium found by EPA during the private well testing (99,900 µg/l or 99.9 mg/l), this would result in the daily intake of calcium from tap water of 199.8 milligrams per day (mg/day) for an adult and 99.9 mg/day for a child. These daily

intakes of calcium are well below the Tolerable Upper Intake Levels (ULs)[k] established by the National Academies, Institute of Medicine, Food and Nutrition Board for dietary calcium[l] for infants (0-12 months), children, and adults (see Table 5).(22;23) As a result, DOH does not consider the calcium levels found in the water from the three private wells in July 2011 to pose a health threat. It should be kept in the mind, however, that there could be seasonal variations in calcium levels in these private wells.

Magnesium

Magnesium was detected at all three tested private wells. The highest magnesium levels were found in the well located in the cherry orchard (26,300 µg/l in sample GW-1 and 26,000 µg/l in the duplicate sample GW-2). Magnesium was also found in the well located near the open field (16,100 µg/l in GW-3) and the well located in the residential yard (13,300 µg/l in GW-4). The magnesium levels found in these three wells are all within the range found in groundwater in Washington (non-detected to 821,000 µg/l).(15)

Magnesium is a naturally occurring element. The general public can be exposed to magnesium in soil, water, air, food, and dust that contain magnesium compounds. Magnesium in water could pose a health threat if large amounts are ingested. However, it is not expected to pose a health threat through skin contact or through inhalation. Adequate levels of magnesium are necessary for good health. Dietary magnesium does not pose a health threat. However, pharmacologic doses of magnesium in supplements can promote health effects such as diarrhea and abdominal cramping.(24)

EPA estimates that an adult drinks about 2 l/day while a child drinks about 1 l/day. When considering the highest level of magnesium found by EPA during the private well testing (26,300 µg/l or 26.3 mg/l), this would result in the daily intake from tap water of 52.6 mg/day for an adult and 26.3 mg/day for a child. It should be kept in the mind however, that there could be seasonal variations in magnesium levels in these private wells.

No ULs are available for dietary magnesium for infants, children, and adults. However, ULs for magnesium supplements for children from 1 to 18 years and adults have been established by the National Academies, Institute of Medicine, Food and Nutrition Board.(24) The highest daily intakes of magnesium from the private wells are below the ULs for magnesium supplements for children from 1 to 18 years and adults (see Table 6).(23) As a result, DOH does not consider the magnesium levels found in the water from the three private wells in July 2011 to pose a health threat to children from 1 to 18 years or adults. ***Families who may be concerned about magnesium levels for children under 1 year old should consider discussing their child's magnesium needs with their pediatricians.***

[k] A *tolerable upper intake level (UL)* is the highest average daily intake that is likely to pose no risk of adverse health effects to almost all individuals in the general population. As intake increases above the UL, the potential risk of adverse effects may increase.(22)

[l] Dietary calcium refers to both food sources and supplements combined.(22)

Potassium

Potassium was detected at all three tested private wells. The highest potassium levels were found in the well located near the open field (5,460 µg/l in sample GW-3). Potassium was also found in the wells located in the cherry orchard (5,080 µg/l in sample GW-1 and 5,070 µg/l in the duplicate sample GW-2) and residential yard (4,540 µg/l in sample GW-4). The potassium levels found in these three wells are within the range found in Washington (non-detected to 58,000 µg/l ).(15)

Potassium is a naturally occurring element. The general public can be exposed to potassium in soil, water, air, food, and dust that contain potassium compounds. Potassium in water could pose a health threat if large amounts are ingested but are not expected to pose a health threat through skin contact or through inhalation. Adequate levels of potassium are necessary for good health. Healthy people (i.e., people without impaired urinary potassium excretion as a result of a medical condition or drug therapy) are not expected to experience hyperkalemia (potassium level in blood that is higher than normal) resulting from ingestion of potassium naturally occurring in food. However, hyperkalemia could theoretically occur if the capacity of the normal kidney to excrete a potassium load is exceeded.(17)

EPA estimates that an adult drinks about 2 l/day while a child drinks about 1 l/day. When considering the highest level of potassium found by EPA during the private well testing (5,460 µg/l or 5.5 mg/l), this would result in the daily intake of potassium from tap water of 11 mg/day for an adult and 5.5 mg/day for a child. No ULs are available for dietary potassium for infants, children, and adults. However, these daily intakes of potassium are well below the National Academies, Institute of Medicine, Food and Nutrition Board's recommended adequate intake (AI)[m] of potassium for infants (0-12 months), children, and adults (see Table 7).(17) As a result, DOH does not consider the potassium levels found in the water from the three private wells in July 2011 to pose a health threat. It should be kept in the mind, however, that there could be seasonal variations in potassium levels in these private wells.

*Soil/Sediment*

Seven contaminants (arsenic, chromium, lead, uranium, vanadium, 4,4' DDE, and 4,4' DDT) were detected above the health comparison value in soil samples (see Tables 3 and 4). However, the analytical methods for eight contaminants (alpha BHC, beta BHC, gamma BHC (lindane), aldrin, dieldrin, heptachlor, heptachlor epoxide, and toxaphene) were not sensitive enough to determine whether these contaminants might be present above or below their respective health comparison values.

The source of these contaminants is unknown. The organic contaminants 4,4' DDE, and 4,4' DDT may be associated with historical pesticide use. The inorganic contaminants, like arsenic and lead, could be naturally occurring. However, lead and arsenic found in soils maybe associated with the past application of lead arsenate, a pesticide, which was widely used in Washington orchards until 1948.(2) Some residues of these pesticides can persist for a long time

[m] *Adequate intakes* are recommended intake values based on observed or experimentally determined estimates of nutrient intake by a group of healthy people that are assumed to be adequate. An adequate intake is established when an RDA cannot be determined.(17)

in soil.

While only a few soil samples were collected, when compared to soil screening levels, these few samples suggest shallow soils at the cherry orchard (SS-1/SS-2) and property near the former silicon plant (SS-3) might be a possible health concern. Of particular concern are the levels of arsenic and lead found in those samples. Because these soils are located in an orchard or near orchard lands, arsenic and lead in soil may be widespread at these properties.

**Data Gaps**

The extent and magnitude of the soil contamination at the cherry orchard property and property near the former silicon plant have not been defined. Until that data gap is filled, DOH cannot assess whether the soil poses a possible health threat.

# Children's Health Considerations

Children can be uniquely vulnerable to the hazardous effects of environmental contaminants, like arsenic, in drinking water and soil. This is because children are smaller and receive higher doses of contaminant exposure per body weight. Additionally, the fetus is highly sensitive to many contaminants, particularly with respect to potential impacts on childhood development. For these reasons, DOH considers the specific impacts that contaminated drinking water and soil might have on children.

# Conclusions

1. Water from the three private domestic wells could harm people's health if used for drinking or food preparation. Food preparation includes washing foods, cooking, or using well water as an ingredient.

2. Water from the three private domestic wells does not pose a health threat if used for bathing and cleaning.

3. Limited soil sampling found potentially harmful levels of lead and arsenic. However, DOH cannot evaluate the likelihood of harm of without further information about the extent and magnitude of the contamination.

# Recommendations

1. Because arsenic in water used for drinking or food preparation could harm people's health, DOH recommends the following:
    - Test private well water periodically[n] to evaluate the safety of the water supply. Because contaminant levels can vary seasonally, DOH recommends testing for

[n] The Washington State Department of Health recommends that private well users test their well water every year for coliform bacteria and nitrate.(1)

arsenic and other contaminants in late summer and in the early spring to see if there are differences.

- Consider the following options for reducing exposure to arsenic: bottled water, an alternate water supply, or install arsenic treatment.[o]

2. Further soil testing should be conducted at the cherry orchard property and property near the former silicon plant. Until then, property owners should take the following steps as a precaution:

    - Wash hands and face with soap and water after working or playing outside and before eating.
    - Prevent soil from being tracked inside:
        - Cover bare soils where children play with grass, bark, gravel, or clean soils.
        - Use doormats at each door.
        - Take off shoes when coming inside.
    - Mop, dust, and vacuum:
        - Damp mop or damp dust floors, windowsills, bookcases, and other surfaces at least once a week.
        - Vacuum carpets and upholstered furniture at least once a week.
        - Use a vacuum cleaner with a filter that captures dust such as a High Efficiency Particulate Arrestor (HEPA) filter.
    - Minimize dust during dry weather by watering exposed soils in gardens and play areas where soil may become airborne.

When testing soil in the future, DOH recommends using analytical methods that are sensitive enough to determine whether the tested contaminants are present above or below their respective health comparison values.

# Public Health Action Plan

### Actions Completed

1. The Chelan-Douglas Health District notified approximately 150 private well owners in the Rock Island area about the arsenic results for the three private wells in April 2012 and offered them an opportunity to have their wells tested for arsenic for free.
2. EPA conducted additional private well testing in October 2012

### Actions Planned

1. DOH will provide copies of this health consultation report to the three private well owners, EPA, and Chelan-Douglas Health District.

[o] DOH's has additional information and recommendations about arsenic and private wells on its website: http://www.doh.wa.gov/Portals/1/Documents/Pubs/334-156.pdf. A copy of that information is provided in Appendix B.

2. DOH will post this health consultation report on its web site to make it available to the general public.

3. Future soil test results, if obtained, can be used by DOH to assess the potential health threat posed by the soil at the orchard, and property across from the open field.

4. DOH will prepare a health consultation addressing the arsenic results from the 34 Rock Island area private wells tested in 2012. The report is anticipated to be completed in 2014.

# Report Preparation

This Health Consultation for the Rock Island Area site was prepared by the Washington Department of Health under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, and procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner. ATSDR has reviewed this document and concurs with its findings based on the information presented.

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# Tables

Table 1: Private Well Water Metal Results and Health Comparison Values, Rock Island Area, Douglas County, Washington

| Metal | Well Concentration (µg/l) | | | | | | | | Health Comparison Value (µg/l) | Health Comparison Value Reference |
|---|---|---|---|---|---|---|---|---|---|---|
| | GW-1 | | GW-2 (DP) | | GW-3 | | GW-4 | | | |
| Aluminum | 10 | U | 10 | U | 10 | U | 20 | U | 10,000 | Child Chronic EMEG |
| Antimony | 1 | U | 1 | U | 1 | U | 2 | U | 4 | Child RMEG |
| Arsenic | **117** | | **114** | | **18.9** | | **2.6** | | 0.023 | CREG |
| Barium | 77.2 | | 78.8 | | 60.1 | | 21.8 | | 2,000 | Child Chronic EMEG |
| Beryllium | 0.05 | U | 0.05 | U | 0.05 | U | 0.1 | U | 20 | Child Chronic EMEG |
| Cadmium | 0.13 | U | 0.13 | U | 0.13 | U | 0.25 | U | 1 | Child Chronic EMEG |
| Calcium | **99,900** | | **97,800** | | **63,300** | | **47,900** | | NA | NA |
| Chromium | 1.3 | U | 1.3 | U | 1.4 | | 2.5 | U | 9 | Child Chronic EMEG- Cr6+ |
| Cobalt | 0.16 | | 0.14 | | 0.071 | | 0.075 | U | 4.7 | EPA Regional Screening Level(33) |
| Copper | 51.1 | | 19 | | 4.4 | | 2.5 | U | 100 | Child Intermediate EMEG |
| Iron | 20 | U | 20 | U | 20 | U | 20 | U | 11,000 | EPA Regional Screening Level |
| Lead | 2.4 | | 0.48 | | 0.2 | | 0.25 | U | 15 | EPA Drinking Water Action Level(20) |
| Magnesium | **26,300** | | **26,000** | | **16,100** | | **13,300** | | NA | NA |
| Manganese | 0.13 | U | 0.13 | U | 1.4 | | 0.43 | | 300 | EPA Lifetime Health Advisory(20) |
| Mercury | 0.05 | U | 0.05 | U | 0.05 | U | 0.05 | U | 3 | Child RMEG - mercuric chloride |
| Molybdenum | 1.2 | | 1.2 | | 4.1 | | 2.7 | | 40 | EPA Lifetime Health Advisory |
| Nickel | 3.1 | J | 2.8 | J | 1.6 | | 1.1 | J | 100 | EPA Lifetime Health Advisory |
| Potassium | **5,080** | | **5,070** | | **5,460** | | **4,540** | | NA | NA |
| Selenium | 1.3 | U | 1.3 | U | 1.3 | U | 2.5 | U | 50 | Child Chronic EMEG |
| Silver | 0.63 | U | 0.63 | U | 0.63 | U | 1.3 | U | 50 | Child RMEG |
| Sodium | **21,400** | | **20,900** | | 16,500 | | 17,200 | | 20,000 | EPA Drinking Water Advisory(20) |
| Thallium | 0.63 | U | 0.63 | U | 0.63 | U | 1.3 | U | 2 | EPA Primary MCL(20) |
| Uranium | 17.3 | | 17.1 | | 7.66 | | 5 | | 30 | EPA Primary MCL |
| Vanadium | 7.89 | | 7.64 | | 5.9 | | 7 | | 100 | Child Intermediate EMEG |
| Zinc | 11.8 | | 9.25 | | 3 | | 5 | U | 3,000 | Child Chronic EMEG |

NA - not available; EPA- Environmental Protection Agency; MCL - maximum contaminant level; DP - duplicate of GW-1; U - undetected at reported level;
J - estimated; µg/l - microgram per liter; EMEG - ATSDR environmental media evaluation guideline; RMEG - ATSDR reference dose media evaluation guideline;
CREG - ATSDR Cancer Risk Evaluation Guideline**; Bold -** concentration exceeds health comparison value or no health comparison is available;
CR6+ - hexavalent chromium

Table 2: Private Well Water Organochloride Pesticides Results and Health Comparison Values, Rock Island Area, Douglas County Washington

| Pesticide | Well Concentration (µg/l) | | | | | | | | Health Comparison Value (µg/l) | Health Comparison Value Reference |
|---|---|---|---|---|---|---|---|---|---|---|
| | GW-1 | | GW-2 (DP) | | GW-3 | | GW-4 | | | |
| alpha-BHC | **0.01** | **U** | **0.01** | **U** | **0.01** | **U** | **0.01** | **U** | 0.0056 | CREG |
| beta-BHC | 0.01 | U | 0.01 | U | 0.01 | U | 0.01 | U | 0.019 | CREG |
| gamma-BHC (lindane) | 0.01 | U | 0.01 | U | 0.01 | U | 0.01 | U | 0.1 | Child Intermediate EMEG |
| delta-BHC | 0.01 | U | 0.01 | U | 0.01 | U | 0.01 | U | 0.1 | Child Intermediate EMEG-Lindane |
| alpha-chlordane | 0.01 | U | 0.01 | U | 0.01 | U | 0.01 | U | 0.1 | CREG - chlordane |
| gamma-chlordane | 0.01 | U | 0.01 | U | 0.01 | U | 0.01 | U | 0.1 | CREG - chlordane |
| 4,4'-DDD | 0.01 | U | 0.01 | U | 0.01 | U | 0.01 | U | 0.15 | CREG |
| 4,4'-DDE | 0.01 | U | 0.01 | U | 0.01 | U | 0.01 | U | 0.1 | CREG |
| 4,4'-DDT | 0.01 | U | 0.01 | U | 0.01 | U | 0.01 | U | 0.1 | CREG |
| Aldrin | **0.01** | **U** | **0.01** | **U** | **0.01** | **U** | **0.01** | **U** | 0.0021 | CREG |
| Dieldrin | **0.01** | **U** | **0.01** | **U** | **0.01** | **U** | **0.01** | **U** | 0.0022 | CREG |
| Endosulfan I | 0.01 | U | 0.01 | U | 0.01 | U | 0.01 | U | 20 | Child Chronic EMEG-Endosulfan |
| Endosulfan II | 0.01 | U | 0.01 | U | 0.01 | U | 0.01 | U | 20 | Child Chronic EMEG-Endosulfan |
| Endosulfan Sulfate | 0.01 | U | 0.01 | U | 0.01 | U | 0.01 | U | 20 | Child Chronic EMEG-Endosulfan |
| Endrin | 0.01 | U | 0.01 | U | 0.01 | U | 0.01 | U | 3 | Child Chronic EMEG |
| Endrin Aldehyde | 0.01 | U | 0.01 | U | 0.01 | U | 0.01 | U | 3 | Child Chronic EMEG-endrin |
| Endrin Ketone | 0.02 | U | 0.02 | U | 0.02 | U | 0.02 | U | 3 | Child Chronic EMEG-endrin |
| Heptachlor | **0.01** | **U** | **0.01** | **U** | **0.01** | **U** | **0.01** | **U** | 0.0078 | CREG |
| Heptachlor Epoxide | **0.01** | **U** | **0.01** | **U** | **0.01** | **U** | **0.01** | **U** | 0.0038 | CREG |
| Methoxyclor | 0.01 | U | 0.01 | U | 0.01 | U | 0.01 | U | 50 | Child RMEG |
| Toxaphene | **0.1** | **U** | **0.1** | **U** | **0.1** | **U** | **0.1** | **U** | 0.032 | CREG |

µg/l - microgram per liter; CREG - ATSDR Cancer Risk Evaluation Guideline; EMEG - ATSDR environmental media evaluation guideline; U - undetected at the reporting limit
**Bold** - reporting limit exceeds health comparison level

Table 3: Soil/Sediment Metal Results and Health Comparison Values, Rock Island Area, Douglas County, Washington

| Metals | Metals Concentrations (mg/kg) in Soil and Sediments | | | | | | | | | | | | | | Health Comparison Value (mg/kg) | Health Comparison Value Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BG-1 (0-0.5 ft) | | BG-2 (3-3.5 ft) | | SS-1 (0-0.5 ft) | | SS-1 (DUP) | | SS-2 (3-3.5 ft) | | SS-3 (0-0.5 ft) | | SD-1 | | | |
| Antimony | 0.24 | J | 0.08 | UJ | 0.58 | J | 0.55 | J | 0.15 | J | 0.14 | J | 0.15 | J | 20 | Child RMEG |
| Arsenic | **66.1** | | **19.2** | | **130** | | **158** | | **40.4** | | **26.8** | | **1.9** | | 0.47 | CREG |
| Barium | 115 | | 84.3 | | 108 | | 128 | | 102 | | 82.6 | | 63.7 | | 10,000 | Child Chronic EMEG |
| Beryllium | 0.34 | | 0.28 | | 0.27 | | 0.27 | | 0.33 | | 0.3 | | 0.18 | | 100 | Child Chronic EMEG |
| Cadmium | 0.19 | | 0.082 | | 0.19 | | 0.38 | | 0.093 | | 0.11 | | 0.059 | | 5 | Child Chronic EMEG |
| Chromium (Total) | **49** | **J** | 27 | J | **53** | **J** | **48** | **J** | 40 | J | 36 | J | **72** | **J** | 45 (CrVI) | Child Chronic EMEG |
| Cobalt | 9.35 | | 7.06 | | 6.64 | | 6.5 | | 6.56 | | 9.15 | | 24.7 | | 500 | Child Intermediate EMEG |
| Copper | 14.4 | | 11.3 | | 10.9 | | | | | | 12 | | 11.3 | | 500 | Child Intermediate EMEG |
| Lead | **656** | | 8.65 | | **2140** | | 10.9 **2760** | | 10.2 97.2 | | 155 | | 7.43 | | 250 | Ecology MTCA Method A(34) |
| Manganese | 331 | | 264 | | 251 | | 278 | | 258 | | 299 | | 251 | | 2,500 | Child RMEG |
| Mercury | 0.016 | | 0.0124 | | 0.045 | | 0.0442 | | 0.0106 | | 0.015 | | 0.013 | | 2 | Ecology MTCA Method A |
| Molybdenum | 0.67 | | 0.36 | | 0.71 | | 0.66 | | 0.51 | | 0.54 | | 1.2 | | 250 | Child RMEG |
| Nickel | 19.9 | | 17 | | 27.7 | | 25.9 | | | | 20.9 | | 35.6 | | 1,000 | Child RMEG |
| Selenium | 0.11 | | 0.054 | | 0.18 | | 0.16 | | 21.9 0.079 | | 0.057 | | 0.044 | | 250 | Child Chronic EMEG |
| Silver | 0.061 | | 0.04 | | 0.07 | | 0.054 | | 0.051 | | 0.049 | | 0.046 | | 250 | Child RMEG |
| Thallium | 0.14 | | 0.089 | | 0.11 | | 0.1 | | 0.1 | | 0.087 | | 0.071 | | 0.78 | EPA Residential Screening Level(33) |
| Uranium | 0.67 | | 0.32 | | 0.97 | | 0.92 | | 0.5 | | 0.76 | | 0.37 | | 10 | Child Intermediate EMEG |
| Vanadium | 32.5 | | 27.6 | | 23.1 | | 23.1 | | 22.8 | | 30.2 | | 25.7 | | 500 | Child Intermediate EMEG |
| Zinc | 61.8 | | 32.8 | | 84.3 | | 87.4 | | 33.7 | | 41.2 | | 30.7 | | 15,000 | Child Chronic EMEG |

mg/kg - milligrams per kilogram; ; BG - Background; SS - surface soil; SD - sediment; DUP - duplicate; J - estimated value; CrVI - chromium VI;
EMEG - ATSDR environmental media evaluation guideline; RMEG - ATSDR reference dose media evaluation guideline; CREG - ATSDR Cancer Risk Evaluation Guideline;
Ecology - Washington Department of Ecology; MTCA - Model Toxics Control Act; **Bold** - concentration exceeds health comparison level

Table 4: Soil/Sediment Organochloride Pesticide Results and Health Comparison Values, Rock Island Area, Douglas County, Washington

| Organochloride Pesticide | Organochloride Concentrations (mg/kg) in Soil and Sediments | | | | | | | | | | | | | | Health Comparison Value (mg/kg) | Health Comparison Value Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BG-1 (0-0.5 ft) | | BG-2 (3-3.5 ft) | | SS-1 (0-0.5 ft) | | SS-1 (DUP) (0-0.5 ft) | | SS-2 (3-3.5 ft) | | SS-3 (0-0.5 ft) | | SD-1 (0-0.5 ft) | | | |
| alpha-BHC | **0.37** | **U** | 0.019 | U | **2** | **U** | **0.98** | **U** | 0.019 | U | **0.87** | **U** | 0.039 | U | 0.11 | CREG |
| beta-BHC | 0.37 | U | 0.019 | U | **2** | **U** | **0.98** | **U** | 0.019 | U | **0.87** | **U** | 0.039 | U | 0.39 | CREG |
| gamma-BHC (lindane) | 0.37 | U | 0.019 | U | **2** | **U** | **0.98** | **U** | 0.019 | U | **0.87** | U | 0.039 | U | 0.5 | Child Intermediate EMEG-beta BHC |
| delta-BHC | 0.37 | U | 0.019 | U | **2** | **U** | 0.98 | U | 0.019 | U | 0.87 | U | 0.039 | U | 0.39 | Child Intermediate EMEG-beta BHC |
| alpha-chlordane | 0.37 | U | 0.019 | U | 2 | U | 0.98 | U | 0.019 | U | 0.87 | U | 0.039 | U | 2 | CREG - chlordane |
| gamma-chlordane | 0.37 | U | 0.019 | U | 2 | U | 0.98 | U | 0.019 | U | 0.87 | U | 0.039 | U | 2 | CREG – chlordane |
| 4,4'-DDD | 0.0079 | J | 0.019 | U | 2 | U | 0.017 | J | 0.019 | U | 0.87 | U | 0.039 | U | 2.9 | CREG |
| 4,4'-DDE | 0.62 | J | 0.0025 | J | **2.8** | **J** | **2.2** | **J** | 0.058 | J | 1.7 | J | 0.0017 | J | 2.1 | CREG |
| 4,4'-DDT | 0.061 | J | 0.00055 | J | **3.9** | **J** | **2.7** | **J** | 0.026 | J | 0.17 | J | 0.0007 | J | 2.1 | CREG |
| Aldrin | **0.37** | **U** | 0.019 | U | **2** | **U** | **0.98** | **U** | 0.019 | U | **0.87** | **U** | 0.039 | U | 0.041 | CREG |
| Dieldrin | **0.37** | **U** | 0.019 | U | **2** | **U** | **0.98** | **U** | 0.019 | U | **0.87** | **U** | 0.039 | U | 0.044 | CREG |
| Endosulfan I | 0.37 | U | 0.019 | U | 2 | UJ | 0.98 | UJ | 0.019 | U | 0.87 | UJ | 0.039 | U | 100 | Child Chronic EMEG - endosulfan |
| Endosulfan II | 0.37 | U | 0.019 | U | 2 | U | 0.98 | U | 0.019 | U | 0.87 | U | 0.039 | U | 100 | Child Chronic EMEG - endosulfan |
| Endosulfan Sulfate | 0.37 | U | 0.019 | U | 2 | U | 0.98 | U | 0.019 | U | 0.87 | U | 0.039 | U | 100 | Child Chronic EMEG - endosulfan |
| Endrin | 0.37 | U | 0.019 | U | 2 | U | 0.98 | U | 0.019 | U | 0.87 | U | 0.039 | U | 15 | Child Chronic EMEG |
| Endrin Aldehyde | 0.37 | U | 0.019 | U | 2 | U | 0.98 | U | 0.019 | U | 0.87 | U | 0.039 | U | 15 | Child Chronic EMEG-endrin |
| Endrin Ketone | 0.37 | U | 0.019 | U | 2 | U | 0.98 | U | 0.019 | U | 0.87 | U | 0.039 | U | 15 | Child Chronic EMEG-endrin |
| Heptachlor | **0.37** | **U** | 0.019 | U | **2** | **U** | **0.98** | **U** | 0.019 | U | **0.87** | **U** | 0.039 | U | 0.16 | CREG |
| Heptachlor Epoxide | **0.37** | **U** | 0.019 | U | **2** | **U** | **0.98** | **U** | 0.019 | U | **0.87** | **U** | 0.039 | U | 0.077 | CREG |
| Methoxychlor | 0.37 | U | 0.019 | U | 2 | U | 0.98 | U | 0.019 | U | 0.87 | U | 0.039 | U | 250 | Child Intermediate EMEG |
| Toxaphene | **3.7** | **U** | 0.19 | U | **20** | **U** | **9.8** | **U** | 0.19 | U | **8.7** | **U** | 0.39 | U | 0.64 | CREG |

mg/kg - milligrams per kilogram; BG - Background; SS - surface soil; SD - sediment; ft - feet; U - undetected at the reporting limit; J - estimated value
EMEG - ATSDR environmental media evaluation guideline; CREG – ATSDR cancer risk evaluation guideline;
**Bold -** concentration or half of the reporting limit exceeds health comparison value

Table 5: Comparison of Arsenic Drinking Water Exposure Doses with ATSDR Acute and Chronic Oral Minimal Risk Levels (MRLs)

| Well Location | Concentration (µg/l) | Age Group | Exposure Dose (mg/kg-day) | | Acute Oral MRL (mg/kg-day) | Doses Exceed Acute Oral MRL? | Chronic Oral MRL (mg/kg-day) | Doses Exceed Chronic Oral MRL? |
|---|---|---|---|---|---|---|---|---|
| | | | RME Scenario | Average Scenario | | | | |
| Orchard | 116* | Birth to <1 year | 0.016 | 0.007 | 0.005 | **Yes** | 0.0003 | **Yes** |
| | | 1 to <2 year | 0.009 | 0.003 | | **Yes - RME** | | **Yes** |
| | | 2 to <6 year | 0.007 | 0.003 | | **Yes - RME** | | **Yes** |
| | | 6 to <11 year | 0.004 | 0.002 | | No | | **Yes** |
| | | 11 to <21 year | 0.004 | 0.001 | | No | | **Yes** |
| | | 21 to <65 year | 0.004 | 0.002 | | No | | **Yes** |
| | | 65 to <78 year | 0.004 | 0.002 | | No | | **Yes** |
| Field | 18.9 | Birth to <1 year | 0.003 | 0.001 | | No | | **Yes** |
| | | 1 to <2 year | 0.001 | 0.0005 | | No | | **Yes** |
| | | 2 to <6 year | 0.001 | 0.0004 | | No | | **Yes** |
| | | 6 to <11 year | 0.0007 | 0.0003 | | No | | **Yes - RME** |
| | | 11 to <21 year | 0.0006 | 0.0002 | | No | | **Yes - RME** |
| | | 21 to <65 year | 0.0007 | 0.0003 | | No | | **Yes - RME** |
| | | 65 to <78 year | 0.0006 | 0.0003 | | No | | **Yes - RME** |
| Yard | 2.6 | Birth to <1 year | 0.0004 | 0.0002 | | No | | **Yes - RME** |
| | | 1 to <2 year | 0.0002 | 0.00007 | | No | | No |
| | | 2 to <6 year | 0.0002 | 0.00006 | | No | | No |
| | | 6 to <11 year | 0.0001 | 0.00004 | | No | | No |
| | | 11 to <21 year | 0.00008 | 0.00003 | | No | | No |
| | | 21 to <65 year | 0.00009 | 0.00004 | | No | | No |
| | | 65 to <78 year | 0.00009 | 0.00004 | | No | | No |

*average of GW-1 and GW-2
mg/kg-day - daily dose in milligrams of contaminant per kilograms bodyweight per day; RME - reasonable maximum exposure;

Table 6: Comparison of Arsenic Drinking Water Exposure Doses with LOAEL Used to Derive the Acute Oral MRL and NOAEL Used to Derive the Chronic Oral MRL

| Well Location | Concentration (µg/l) | Age Group | Exposure Dose (mg/kg-day) | | LOAEL (mg/kg-day) used to Derive Acute MRL | Doses Exceed LOAEL? | NOAEL (mg/kg-day) used to Derive Chronic MRL | Doses Exceed NOAEL? |
|---|---|---|---|---|---|---|---|---|
| | | | RME Scenario | Average Scenario | | | | |
| Orchard | 116* | Birth to <1 year | 0.016 | 0.007 | 0.05 | No | 0.0008 | **Yes** |
| | | 1 to <2 year | 0.009 | 0.003 | | No | | **Yes** |
| | | 2 to <6 year | 0.007 | 0.003 | | No | | **Yes** |
| | | 6 to <11 year | 0.004 | 0.002 | | No | | **Yes** |
| | | 11 to <21 year | 0.004 | 0.001 | | No | | **Yes** |
| | | 21 to <65 year | 0.004 | 0.002 | | No | | **Yes** |
| | | 65 to <78 year | 0.004 | 0.002 | | No | | **Yes** |
| Field | 18.9 | Birth to <1 year | 0.003 | 0.001 | | No | | **Yes** |
| | | 1 to <2 year | 0.001 | 0.0005 | | No | | **Yes - RME** |
| | | 2 to <6 year | 0.001 | 0.0004 | | No | | **Yes - RME** |
| | | 6 to <11 year | 0.0007 | 0.0003 | | No | | No |
| | | 11 to <21 year | 0.0006 | 0.0002 | | No | | No |
| | | 21 to <65 year | 0.0007 | 0.0003 | | No | | No |
| | | 65 to <78 year | 0.0006 | 0.0003 | | No | | No |
| Yard | 2.6 | Birth to <1 year | 0.0004 | 0.0002 | | No | | No |
| | | 1 to <2 year | 0.0002 | 0.00007 | | No | | No |
| | | 2 to <6 year | 0.0002 | 0.00006 | | No | | No |
| | | 6 to <11 year | 0.0001 | 0.00004 | | No | | No |
| | | 11 to <21 year | 0.00008 | 0.00003 | | No | | No |
| | | 21 to <65 year | 0.00009 | 0.00004 | | No | | No |
| | | 65 to <78 year | 0.00009 | 0.00004 | | No | | No |

*average of GW-1 and GW-2

mg/kg-day - daily dose in milligrams of contaminant per kilograms bodyweight per day; LOAEL - lowest observed adverse effect level; NOAEL - no observed adverse effect level

Table 7: Estimated Cancer Risk: Arsenic in Drinking Water

| Well Location | Concentration (µg/l) | Age Group | Excess Cancer Risk | |
|---|---|---|---|---|
| | | | RME Scenario | Average Scenario |
| Orchard | 116* | Birth to <1 year | 1.2E-03 | 5.5E-04 |
| | | 1 to <2 year | 6.6E-04 | 2.3E-04 |
| | | 2 to <6 year | 2.1E-03 | 7.8E-04 |
| | | 6 to <11 year | 1.7E-03 | 6.4E-04 |
| | | 11 to <21 year | 2.7E-03 | 9.9E-04 |
| | | 21 to <65 year | 1.3E-02 | 5.5E-03 |
| | | 65 to <78 year | 3.8E-03 | 1.8E-03 |
| | | Total Risk | 2.5E-02 | 1.1E-02 |
| Field | 18.9 | Birth to <1 year | 2.0E-04 | 8.9E-05 |
| | | 1 to <2 year | 1.1E-04 | 3.7E-05 |
| | | 2 to <6 year | 3.3E-04 | 1.3E-04 |
| | | 6 to <11 year | 2.7E-04 | 1.0E-04 |
| | | 11 to <21 year | 4.4E-04 | 1.6E-04 |
| | | 21 to <65 year | 2.2E-03 | 9.0E-04 |
| | | 65 to <78 year | 6.2E-04 | 2.9E-04 |
| | | Total Risk | 4.1E-03 | 1.7E-03 |
| Yard | 2.6 | Birth to <1 year | 2.7E-05 | 1.2E-05 |
| | | 1 to <2 year | 1.5E-05 | 5.1E-06 |
| | | 2 to <6 year | 4.6E-05 | 1.8E-05 |
| | | 6 to <11 year | 3.7E-05 | 1.4E-05 |
| | | 11 to <21 year | 6.0E-05 | 2.2E-05 |
| | | 21 to <65 year | 3.0E-04 | 1.2E-04 |
| | | 65 to <78 year | 8.5E-05 | 4.0E-05 |
| | | Total Risk | 5.7E-04 | 2.4E-04 |

*average of GW-1 and GW-2

Table 8: Lifetime Cancer Risk: Arsenic in Water

| Well Location | Concentration (µg/l) | Lifetime Cancer Risk | |
|---|---|---|---|
| | | RME Scenario | Average Scenario |
| Orchard | 116* | 2.5E-02 | 1.1E-02 |
| Field | 18.9 | 4.1E-03 | 1.7E-03 |
| Yard | 2.6 | 5.7E-04 | 2.4E-04 |

RME - reasonable maximum exposure
*Average of sample and duplicate

Table 9: National Academies, Institute of Medicine, Food and Nutrition Board Tolerable Upper Intake Levels (ULs) for Calcium (23)

| Age | Male (mg/day) | Female (mg/day) | Pregnant (mg/day) | Lactating (mg/day) |
|---|---|---|---|---|
| 0-6 months | 1,000 | 1,000 | - | - |
| 7-12 months | 1,500 | 1,500 | - | - |
| 1-8 years | 2,500 | 2,500 | - | - |
| 9-18 years | 3,000 | 3,000 | 3,000 | 3,000 |
| 19-50 years | 2,500 | 2,500 | 2,500 | 2,500 |
| 51+ years | 2,000 | 2,000 | - | - |

mg/day - milligrams per day

Table 10: National Academies, Institute of Medicine, Food and Nutrition Board Tolerable Upper Intake Levels (ULs) for Supplemental Magnesium (24)

| Age | Males (mg/day) | Females (mg/day) | Pregnant (mg/day) | Lactating (mg/day) |
|---|---|---|---|---|
| Infants | Undetermined | Undetermined | - | - |
| 1-3 | 65 | 65 | - | - |
| 4-8 | 110 | 110 | - | - |
| 9-18 | 350 | 350 | 350 | 350 |
| 19+ | 350 | 350 | 350 | 350 |

mg/day - milligrams per day

Table 11: National Academies, Institute of Medicine, Food and Nutrition Board Adequate Intake (AI) for Potassium(17)

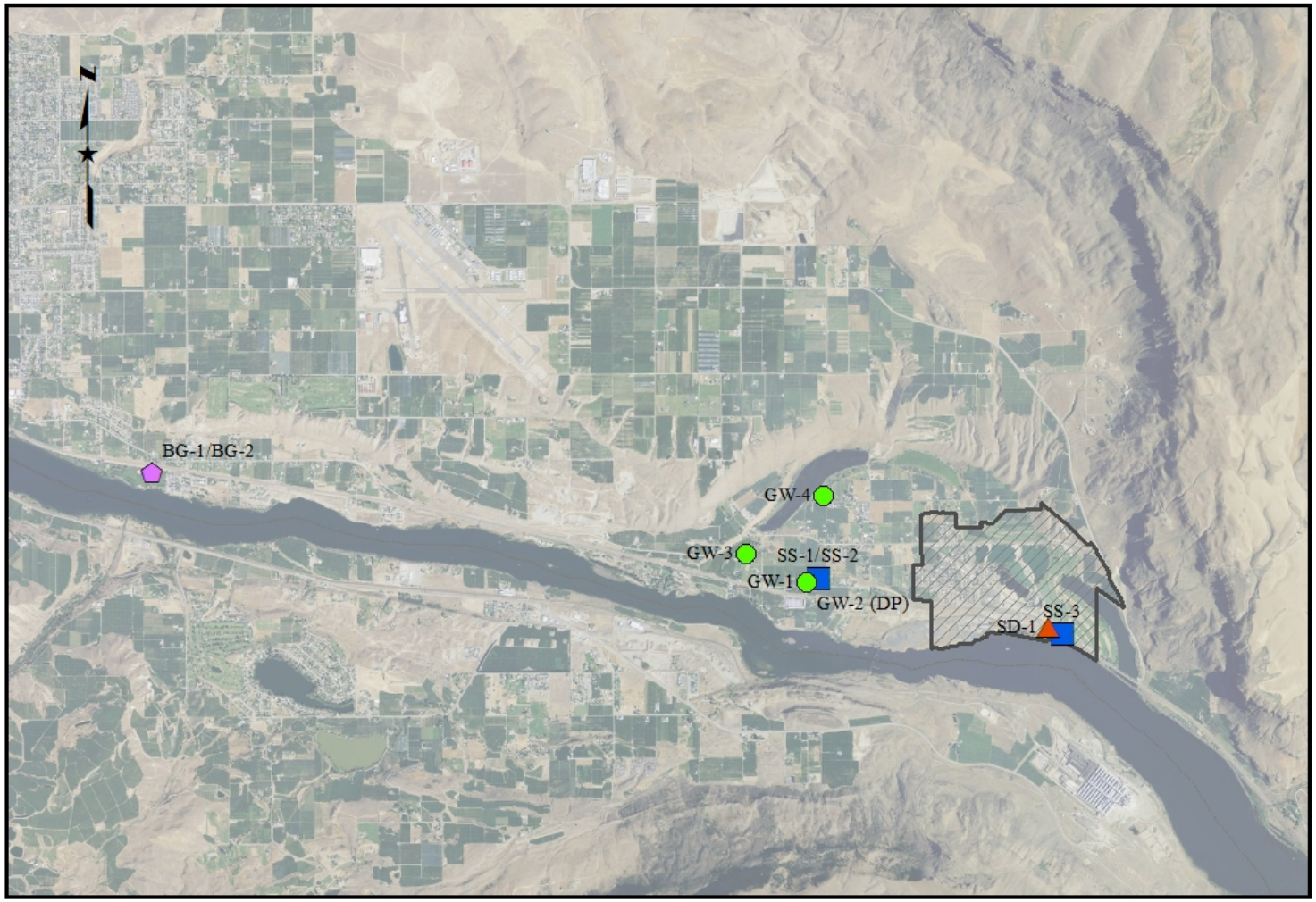
| Life Stage | Age | Males (mg/day) | Females (mg/day) |
|---|---|---|---|
| Infants | 0-6 months | 400 | 400 |
| Infants | 7-12 months | 700 | 700 |
| Children | 1-3 years | 3,000 | 3,000 |
| Children | 4-8 years | 3,800 | 3,800 |
| Children | 9-13 years | 4,500 | 4,500 |
| Adolescents | 14-18 years | 4,700 | 4,700 |
| Adults | 19 years and older | 4,700 | 4,700 |
| Pregnancy | 14-50 years | - | 4,700 |
| Breast-feeding | 14-50 years | - | 5,100 |

mg/day – milligrams per day

# Figures


Source: National Geographic and ESRI

**Figure 1**
**Rock Island Vicinity Map**
**Douglas County, Washington**



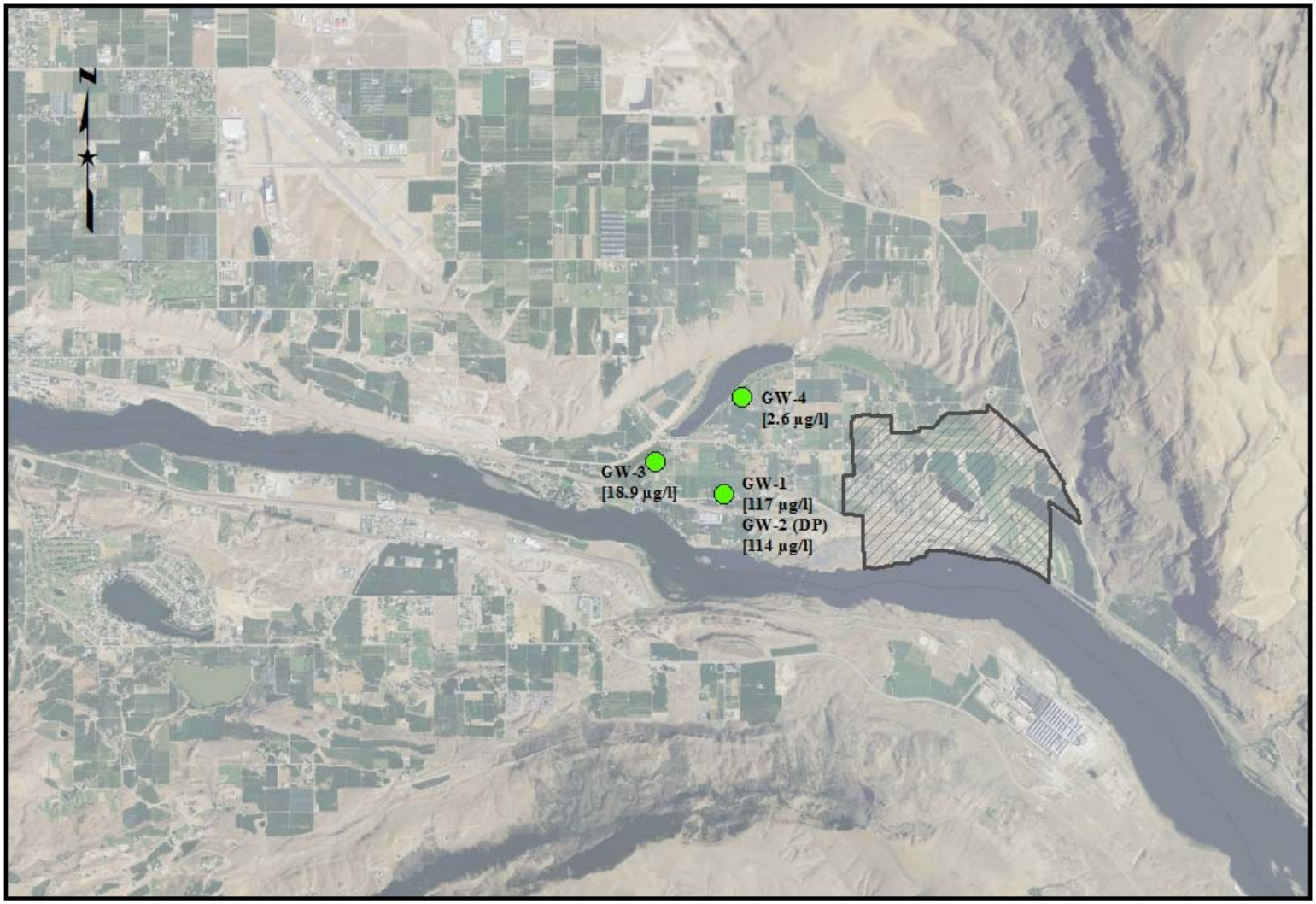

Source: ArcGIS Map Service NAIP2011

0 0.25 0.5 1
Miles

Sample Locations

City of Rock Island
BG-2 Background
GW-4 Groundwater
SD-1 Sediment
SS-3 Soil
*DP - duplicate sample*

Figure 2
Sample Locations
Rock Island, Douglas County, Washington




Source: ArcGIS Map Service NAIP2011

0 0.25 0.5 1
Miles

**Arsenic Concentrations**

City of Rock Island

GW-4 Groundwater

*DP- duplicate sample*

**Arsenic concentrations are in micrograms per liter (µg/l)*

**Figure 3**
**Arsenic Concentrations**
**Rock Island, Washington**

# Appendices

**Appendix A – Glossary**

| | |
|---|---|
| **Acute** | Occurring over a short time [compare with **chronic**]. |
| **Agency for Toxic Substances and Disease Registry (ATSDR)** | The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services. |
| **Aquifer** | An underground formation composed of materials such as sand, soil, or gravel that can store and/or supply groundwater to wells and springs. |
| **Cancer Risk Evaluation Guide (CREG)** | The concentration of a contaminant in air, soil, or water that is expected to cause no more than one excess cancer in a million persons exposed over a lifetime. The CREG is a *comparison value* used to select contaminants of potential health concern and is based on the *cancer slope factor* (CSF). |
| **Carcinogen** | Any substance that causes cancer. |
| **Chronic** | Occurring over a long time (more than 1 year) [compare with **acute**]. |
| **Comparison Value (CV)** | Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process. |
| **Contaminant** | A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects. |
| **Dermal Contact** | Contact with (touching) the skin [see **route of exposure**]. |

| | |
|---|---|
| **Dose (for contaminants that are not radioactive)** | The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs. |
| **Environmental Media Evaluation Guide (EMEG)** | A concentration in air, soil, or water below which adverse non-cancer health effects are not expected to occur. The EMEG is a comparison value used to select contaminants of potential health concern and is based on ATSDR's minimal risk level (MRL). |
| **Environmental Protection Agency (EPA)** | United States Environmental Protection Agency. |
| **Exposure** | Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [see **acute exposure**], of intermediate duration, or long-term [see **chronic exposure**]. |
| **Groundwater** | Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with **surface water**]. |
| **Hazardous Substance** | Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive. |
| **Ingestion** | The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see **route of exposure**]. |
| **Ingestion Rate (IR)** | The amount of an environmental medium that could be ingested typically on a daily basis. Units for IR are usually liter per day (1/day) for water and milligrams per day (mg/day) for soil. |

| | |
|---|---|
| **Inhalation** | The act of breathing. A hazardous substance can enter the body this way [see **route of exposure**]. |
| **Inorganic** | Compounds composed of mineral materials, including elemental salts and metals such as iron, aluminum, mercury, and zinc. |
| **Lowest Observed Adverse Effect Level (LOAEL)** | The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals. |
| **Maximum Contaminant Level (MCL)** | A drinking water regulation established by the Federal Safe Drinking Water Act and Washington State Administrative Code 246-290. It is the maximum permissible concentration of a contaminant in water that is delivered to the free flowing outlet of the ultimate user of a public water system. MCLs are enforceable standards. |
| **Media** | Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants. |
| **Minimal Risk Level (MRL)** | An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see **reference dose**]. |
| **Model Toxics Control Act (MTCA)** | The hazardous waste cleanup law for Washington State. |
| **No Observed Adverse Effect Level (NOAEL)** | The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals. |
| **Oral Reference Dose (RfD)** | An amount of contaminant ingested into the body (i.e., dose) below which health effects are not expected. RfDs are published by EPA. |

| | |
|---|---|
| **Organic** | Compounds composed of carbon, including materials such as solvents, oils, and pesticides that are not easily dissolved in water. |
| **Parts Per Billion (ppb)/Parts Per Million (ppm)** | Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichloroethylene (TCE) in 1 million ounces of water is 1 ppm. 1 ounce of TCE in 1 billion ounces of water is 1 ppb. If one drop of TCE is mixed in a competition size swimming pool, the water will contain about 1 ppb of TCE. |
| **Reference Dose Media Evaluation Guide (RMEG)** | A concentration in air, soil, or water below which adverse non-cancer health effects are not expected to occur. The EMEG is a *comparison value* used to select contaminants of potential health concern and is based on EPA's oral reference dose (RfD). |
| **Route of Exposure** | The way people come into contact with a hazardous substance. Three routes of exposure are breathing [see **inhalation**], eating or drinking [see **ingestion**], or contact with the skin [see **dermal contact**]. |
| **Surface Water** | A body of water, such as lakes, rivers, streams, and ponds that are open to the atmosphere and subject to surface runoff [compare with **groundwater**]. |

## Appendix B – Arsenic and Your Private Well

### How are people exposed to arsenic?

Everyone has some daily exposure to arsenic because it is a naturally-occurring chemical element that is normally found in water, soil, indoor house dust, air, and food.

Arsenic in your water supply can get into your body when you drink the water or use it to cook or prepare food and beverages.

Arsenic is not absorbed very well through the skin and does not easily evaporate from water. As a result, bathing or washing dishes in arsenic-contaminated water, is unlikely to cause health problems.

Arsenic gets into well water through natural processes. As ground water flows through rocks and soil that contain arsenic, some of the arsenic dissolves into the water. Drinking water in Washington typically contains less than 3 parts of arsenic per billion parts of water (often abbreviated as 3 ppb). For comparison, 3 ppb is about equal to adding one teaspoon of arsenic to an acre of water that is 4 feet deep. However, levels from 10 ppb to 33,000 ppb have been found in some wells in Washington. These are usually associated with ground water located in rock or soil that has a naturally high content of arsenic.

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For more information, contact the Washington State Department of Health at 1-877-485-7316 or www.doh.wa.gov/etoxcontact.

This document is available in other formats for people with disabilities. To submit a request, please call 1-800-525-0127 (TDD/TTY call 711).

# Arsenic
## and Your Private Well

Arsenic is found in well water throughout Washington, sometimes at levels that may cause health problems.

Testing a water sample is the only way to know how much arsenic is present.

*The Washington State Department of Health recommends that water used for drinking or food preparation contain no more than 10 parts per billion (ppb) arsenic.*

Washington State Department of Health

### What health problems can be caused by arsenic?

Swallowing relatively large amounts of arsenic (even just one time) can cause mild symptoms, serious illness, or in extreme cases, death. Milder effects may include swelling of the face, nausea, vomiting, stomach pain, or diarrhea. Serious effects may include coma, internal bleeding, or nerve damage causing weakness or loss of sensation in the hands, arms, feet, or legs. Only a few private drinking water wells in Washington have been found to have this much arsenic.

Long-term exposure to smaller amounts of arsenic is more common and can increase the risk of developing cancer of the bladder, lung, skin, liver, kidney, or prostate. Other health effects may include high blood pressure, narrowing of the blood vessels, nerve damage, anemia, diabetes, stomach upset, and skin changes.

Talk with your health care provider if you think you have any health problems that may be caused by exposure to arsenic.

### Should I be concerned?

Most health problems from long-term arsenic exposure are common illnesses that affect many people and have several possible causes besides arsenic.

Even with relatively high levels of arsenic in the water, we expect that these health problems usually are not caused by arsenic exposure, but are mostly due to other factors such as diet, genes, lifestyle, other chemicals, and preexisting illness.

Still, arsenic is known to increase the risk of developing these illnesses and likely contributes to some of the cases we see.

It is difficult to predict whether arsenic in drinking water will affect you, or what the effects will be. The risk that you will get sick depends on:

- Your individual sensitivity to arsenic.
- The amount of arsenic in the water.
- How much water you consume.
- How many years you drink the water.

Exposures that can cause serious health problems for some people may have no effect on others. Also, two people with similar exposures may develop totally different health problems. *However, more exposure to arsenic increases the likelihood that health problems will occur. Reducing exposure reduces the risk.*

## Should I get my well tested for arsenic?

We encourage you to test your private well to evaluate the safety of your drinking water supply. Arsenic levels are higher than 10 ppb in many wells in Washington. The only way to know how much arsenic is in your water is to test it.

Because the amount of arsenic in well water can vary throughout the year, you should test for it in late summer and in the early spring to see if there are seasonal differences.

Laboratories usually charge $20 to $35 for the test. You can find a list of labs online at: https://fortress.wa.gov/ecy/laboratorysearch or by calling the Washington State Department of Ecology's Laboratory Accreditation Unit at 360-871-8840. The laboratory can provide instructions for taking a sample and will often supply a container.

## What do my test results mean?

To lower people's risk of health problems, the federal Safe Drinking Water Act requires 10 ppb or less arsenic in *public drinking water suppliers* that serve more than fourteen homes. When setting this requirement for arsenic, the U.S. Environmental Protection Agency considered the health risks, as well as the cost and difficulty of removing arsenic down to that amount.

Although a few counties in Washington have rules for arsenic in private water systems, *there is no state-wide standard for arsenic in private wells.* Where there are no county rules, it is up to each private well owner to decide whether he or she wants to take steps to reduce the levels of arsenic in their well water.

We recommend that water used for drinking or food preparation contain no more than 10 ppb arsenic. While reducing arsenic below 10 ppb can lower your chance of developing health effects, it is not low enough to completely eliminate that risk.

If your water contains between 10 ppb and 50 ppb arsenic, your chance of developing health problems increases. We recommend you not drink water containing these levels or use it for food preparation over the long term.

In either case, you will need to balance the health risks, costs, and convenience when deciding whether or not to continue to use your water supply.

If your water contains more than 50 ppb arsenic, we recommend you stop using it immediately for drinking and food preparation.

Since arsenic does not pass through your skin very easily and does not easily evaporate, it is okay to bathe and clean with water unless it contains more than 500 ppb. If the levels in your water are greater than 500 ppb, you should call your local health department or the Department of Health for advice.

## How can I reduce my exposure to arsenic from my well?

There are several ways to reduce your exposure to arsenic in your well water. Each alternative has advantages and disadvantages to consider. If you have arsenic in your water above 500 ppb, you should talk to your local health department or the Department of Health before choosing an option.

**Use Bottled Water**
Drinking and cooking with bottled water can reduce your exposure immediately while you consider your options. However, it can be inconvenient and costly in the long run. You should also contact the bottled water supplier to ask about the levels of any impurities, including arsenic, that their water may contain.

**Treat the Well Water**
Many water filters on the market can improve the taste and remove odors from drinking water but do not remove arsenic. Some home water treatment systems that use reverse osmosis, distillation, or special filtration material can reduce the amount of arsenic in the water. These systems vary in cost and the amount of water they can supply every day. Point-of-entry equipment, commonly referred to as a whole-house system, treats all the water used in the house. Point-of-use systems treat water at a single tap, such as a kitchen sink faucet.

The quality of your water will affect how well the treatment system works and how much maintenance it will require.

We recommend installing equipment that has been certified by NSF International, a not-for-profit public health and safety company that tests home water treatment systems. Call 1-800-673-6275 or go to their website, http://www.nsf.org. After installation and routine maintenance, your water should be tested to ensure that the system is removing arsenic.

**Drill a New Well**
A new well installed at a different location or depth may or may not provide water with acceptable levels of arsenic. However, it is an option that may be worth pursuing in some situations.

**Connect to a Public Water Supply or Community Well**
It may be possible to connect to a public water supply or community well if one is nearby. These water systems must be maintained regularly and meet federal and state public health standards. Contact your local water utility to ask about the possibility of connecting to a public supply.

## Appendix C – Equations and Input Parameters

$$D = \frac{C * IR * EF}{BW}$$

where,

D = exposure dose (mg/kg-day)

C = contaminant concentration (mg/L)

IR = ingestion rate of contaminated water (L/day)

EF = exposure factor (unitless)

BW = body weight (kg)

Age Specific Water Ingestion Rates and Body Weights

| **Units:** | L/day | L/day | kg |
|---|---|---|---|
| **Age group** | RME ingestion rate | Average ingestion rate | Body Weight |
| **Birth to <1 yr** | 1.113 | 0.504 | 7.8 |
| **1 to <2 yr** | 0.893 | 0.308 | 11.4 |
| **2 to <6 yr** | 1.052 | 0.402 | 17.4 |
| **6 to <11 yr** | 1.251 | 0.48 | 31.8 |
| **11 to <21 yr** | 2.042 | 0.753 | 64.2 |
| **21 to <65 yr** | 2.848 | 1.183 | 80.0 |
| **65 to <78 yr** | 2.604 | 1.242 | 76.0 |

L/day – liters per day
Kg - kilograms

**Cancer Risk** = (Age-specific Dose * Cancer Slope Factor) * $\frac{\text{Age-specific Years of Exposure}}{\text{Lifetime in years}}$

Lifetime in Years = 78

| **Age group** | Years of Exposure |
|---|---|
| **Birth to <1 yr** | 1 |
| **1 to <2 yr** | 1 |
| **2 to <6 yr** | 4 |
| **6 to <11 yr** | 5 |
| **11 to <21 yr** | 10 |
| **21 to <65 yr** | 44 |
| **65 to <78 yr** | 13 |

Adjusted Exposure Assumptions for RAIS Calculator for Residential Exposure to Tap Water

| **Adjusted Exposure Assumptions** | **Value** |
|---|---|
| BW0-2 (body weight) kg | 11 |
| BW2-6 (body weight) kg | 17 |
| BW6-16 (body weight) kg | 41 |
| BW16-30 (body weight) kg | 72 |
| | |
| ETresw (exposure time) hour/event | 0.33 |
| | |
| SA0-2 (skin surface area) cm2 | 6030 |
| SA2-6 (skin surface area) cm2 | 7310 |
| SA6-16 (skin surface area) cm2 | 11800 |
| SA16-30 (skin surface area) cm2 | 20000 |

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