Health Consultation

CITY OF WARDEN

EDB DRINKING WATER WELL CONTAMINATION

WARDEN, GRANT COUNTY, WASHINGTON

SEPTEMBER 8, 2005

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR 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 which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

CITY OF WARDEN

EDB DRINKING WATER WELL CONTAMINATION

WARDEN, GRANT COUNTY, WASHINGTON

Prepared by:

Washington State Department of Health
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Forward

The Washington State Department of Health (DOH) has prepared this health consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to hazardous waste. This health consultation was prepared in accordance with methodologies and guidelines developed by ATSDR.

The purpose of this health consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on specific health issues so that DOH can respond to requests from concerned residents or agencies for health information on hazardous substances. DOH evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health. The findings in this report are relevant to conditions at the site during the time of this health consultation, and should not necessarily be relied upon if site conditions or land use changes in the future.

For additional information or questions regarding DOH or the contents of this health consultation, please call the health advisor who prepared this document:

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For more information about ATSDR, contact the ATSDR Information Center at 1-888-422-8737 or visit the agency's Web site: www.atsdr.cdc.gov/.

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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	A theoretical risk for developing cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.
Cancer Slope Factor	A number assigned to a cancer causing chemical that is used to estimate its ability to cause cancer in humans.
Carcinogen	Any substance that causes cancer.
Chronic	Occurring over a long time (more than 1 year) [compare with **acute**].
Comparison value	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 chemicals 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 Protection Agency (EPA)	United States Environmental Protection Agency.
Epidemiology	The study of the occurrence and causes of health effects in human populations. An epidemiological study often compares two groups of people who are alike except for one factor, such as exposure to a chemical or the presence of a health effect. The investigators try to determine if any factor (i.e., age, sex, occupation, economic status) is associated with the health effect.
Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [**acute exposure**], of intermediate duration, or long-term [**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	The amount of an environmental medium that could be ingested typically on a daily basis. Units for IR are usually liter/day for water, and 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. 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**].
No apparent public health hazard	A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.
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 chemical 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.
Route of exposure	The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].
Volatile organic compound (VOC)	Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Summary and Statement of Issues

In June 2003, the City of Warden conducted routine drinking water testing and found ethylene dibromide (EDB), also known as 1, 2-dibromoethane, at levels above the Environmental Protection Agency's (EPA) maximum contaminant level (MCL) in two of the city's three water supply wells. The City of Warden notified the Washington State Department of Health (DOH) Office of Drinking Water of the exceedance. DOH has prepared this health consultation at the request of the Grant County Health District (GCHD) and the City of Warden to evaluate the potential health hazard posed by the EDB found in the city's drinking water supply. DOH prepares public health consultations (PHCs) under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

Background

Public Water

City of Warden Water System

The City of Warden, hereafter referred to as the City, is located in Grant County, Washington (See Figure 1). The City's water system has three municipal wells (Well No. 4, 5 and 6) located inside of the city limits and services about 1500 customers in the area. The groundwater is drawn from the Odessa aquifer sub-basin area at a depth of approximately 360 feet for wells No. 4 (screens at about 80 feet) and 5 (screens at about 54 feet), and a depth of approximately 830 feet for well No. 6. Wells No. 5 and 6 are the two main drinking water drinking water supply wells for the City. They are both treated for bacteria via chlorination before distribution to the customers. Well No. 6 is located in the eastern section of the city, and primarily used to service the City. Well No.5 is sometimes blended with water from Well No.6 to augment the supply to the City when necessary. Well No.4 is an emergency well and has not been used in several years because of its proximity to a railroad line and a potato-processing plant. Wells 4 and 5 are located in the western section of the city and are spaced approximately 1,000 feet apart (See Figure 2).

The City also has two other wells that are not part of the City's water system (Well No. 2 and 3). Well No. 2 is a former private well located in the south of the City. In 2001, the City purchased the water rights for Well No. 2 from a local farmer. In the transfer process with Washington State Department of Ecology (Ecology), the City agreed to make it a monitoring well by drilling it an additional 200 feet. Well No. 3 is an older well that has not been in service since the mid 1970s when the shaft broke and could not be repaired. Well # 3 is located about 200 feet northeast of Well No.6.

The Safe Drinking Water Act (SDWA), enforced by DOH, requires the City to monitor organic, inorganic, and radiological components in the groundwater biannually. In April 1992, EDB contamination was detected in two wells (No. 4 and 5) [1]. DOH provided information on health-effects resulting from exposure to EDB, which the city distributed to water customers [1]. DOH initiated compliance action on the system that required increased monitoring frequency. Subsequent testing of the City water system showed wells No. 4 and 5 it to be free of the

presence of EDB until June 2003 when water samples tested positive for the presence of EDB in both wells (Table 1 and 2) at levels above the maximum contaminant level (MCL) of 0.05 parts per billion (ppb). The City notified the Washington State Department of Health Office of Drinking Water (ODW) of the EDB (MCL) exceedances.

The Public Notification (PN) Rule requires the City to notify its consumers that EDB exceeded the maximum contaminant level (MCL). According to the PN Rule, violating the EDB MCL is a "Tier 2" violation. A Tier 2 violation requires public notification within 30 days of learning that a violation of the MCL has occurred. State and federal drinking water regulations require the City to inform its customers that some people who drink water-containing EDB in excess of the MCL over many years could experience problems with their liver, stomach, reproductive system, or kidneys, and may have an increased risk of getting cancer.

In February 2004, Ecology and the GCHD collected additional water samples from several drinking water wells near Warden. These wells are not part of the City's water system but draw water from similar depth as Wells 4 and 5 are screen. Analysis of these samples failed to detect EDB.

The City consulted with ODW to determine the appropriate measures for dealing with recurring levels of EDB exceeding the MRL. ODW determined that the City must collect and analyze water samples for EDB from each of the City's three wells every three months until each source is determined to be reliably and consistently below the MCL. The City publishes a public notice in the newspaper every three months providing information on the levels of EDB and actions taken to reduce these levels (See Appendix C).

In Spring 2005, the City received a one million dollar grant from the Community Development Block Grant for the engineering and design for a new well. In addition, a one million dollar grant in the Washington State Governor's budget that will be administered by Ecology's, Toxic Cleanup Programs (July 2005) to finish the new well, reconstruction of Wells No. 5 and 6, decommission Wells No. 3 and 4, and reconstruction of Well No. 2 as a monitoring well.

Table 1. Concentration of Ethylene Dibromide detected in the City of Warden Well No.4, Warden, Grant County, Washington.

Well Number	Ethylene Dibromide (EDB)			EPA Cancer Class
	Date Sampled	Results (ppb)	MCL (ppb)	
4	2/8/05	**0.724**	0.05	B2
	11/9/04	0.04		
	10/12/04	0.02		
	3/2/04	**1.62**		
	12/9/03	**0.36**		
	11/18/03	**0.46**		
	8/20/03	0.033		
	8/20/03	0.038		
	6/24/03	**0.091**		

Bold numbers indicate levels exceed the MCL
Well 4 primarily used as emergency well. Not frequently used

Table 2. Concentration of Ethylene Dibromide detected in the City of Warden Well No.5, Warden, Grant County, Washington.

Well Number	Ethylene Dibromide (EDB)			EPA Cancer Class
	Date Sampled	Results (ppb)	MCL (ppb)	
5	4/12/05	**0.15**	0.05	B2
	2/8/05	**0.148**		
	1/10/05	**0.15**		
	11/9/04	**0.06**		
	10/12/04	**0.05**		
	5/11/04	**0.17**		
	4/6/04	**0.50**		
	3/2/04	**0.4**		
	2/9/04	**0.38**		
	2/9/04	0.04*		
	1/21/04	**0.33**		
	11/18/03	**0.09**		
	9/29/03	**0.063**		
	8/20/03	**0.061**		
	6/24/03	**0.092**		

Bold numbers indicate levels exceed the MCL
Well 5 is primarily used to service industrial/commercial processes. Sometimes used to augment residential water supply from well 6.
* Well No.5 and 6 blended

Discussion

Ethylene dibromide (EDB or 1,2-dibromoethane) was found in 2 of 3 wells used to supply water to the City. The presence of EDB alone does not necessarily indicate that adverse health effects will occur. EDB was used extensively in the past as a soil fumigant pesticide and leaded-gasoline additive. Due to an EPA ban on the use of EDB as a soil fumigant in 1984 and increased regulation of leaded gasoline, EDB use has substantially declined in the United States. The source of the EDB in the City water system is unknown. EDB is a volatile organic compound, which can be absorbed into the body during domestic use of EDB contaminated water. People can be exposed to EDB through drinking water, dermal absorption while bathing, and inhaling it after it has been released from the water while cooking and bathing. The MCL for EDB in drinking water is 0.05 ppb. MCLs are enforceable standards established by EPA and designed to be protective of human health. Levels above the MCL do not necessarily mean that adverse health effects will occur.

Exposure to EDB in water

The most obvious route of exposure to EDB in drinking water is ingestion. However, the ability of EDB to volatilize from water makes it available for inhalation from indoor air particularly during bathing and showering. Breathing EDB from indoor air and dermal absorption from water during normal household use is expected to contribute only a small fraction of the total dose (Appendix A, Table A2).

Non-cancer effects

In order to evaluate the potential for non-cancer adverse health affects that may result from exposure to EDB in water, a dose is estimated for each route of exposure (ingestion, dermal, and inhalation). These doses are calculated for situations by which residents might contact the contaminated media. The total estimated dose is compared to a health guideline. If the estimated exposure dose is below the health guideline, then the exposure is not likely to result in health effects. If the estimated dose exceeds the health guideline, then additional analysis is needed to decide if health effects are likely.

EPA's oral reference dose (RfD) for EDB was the health guideline chosen to evaluate potential exposures from well #5. RfDs are doses below which non-cancer adverse health effects are not expected to occur. These doses take into account the differences between animals and humans and difference among people. They are derived from toxic effect levels obtained from human population and laboratory animal studies. Because of uncertainty in these data, the toxic effect level is divided by "safety factors" to produce the lower and more protective RfD.

The chronic oral RfD for EDB is 0.009 mg/kg/day based on cellular necrosis in rats. Other non-cancer health effects associated with EDB exposure are problems with the liver, stomach, reproductive system, and kidneys [2]. These health effects occurred in animal studies after exposure to very high levels of EDB. Workers exposed to high levels of EDB experienced damage to sperm cells.

People who are users of water from the City's wells may be exposed through multiple routes and pathways. EDB can enter the body through ingestion of drinking water, through the skin during bathing, through inhalation of EDB in the shower or while boiling water on the stove. Exposure doses were calculated for people exposed through all pathways. Exposure equations and assumptions are provided in Appendix A, Table A2. This PHC assumes people are exposed everyday for five years to the maximum level measured in Well No. 5 (0.5 ppb). Because Well No. 4 is not currently used as a source of drinking water, only Well No. 5 contamination results will be used in the EDB evaluation. This assumption is protective of public health because Well No. 5 is primarily used to augment the City water supply when necessary. Well No. 6 primarily supplies the City, and there have been no current or historical EDB detections in this well. The highest estimated exposure dose was 3.0 E-5 mg/kg/day and is below the RfD (9.0 E-3 mg/kg/day). Therefore exposure to water from well #5 for five years would not result in any non-cancer adverse health effects.

In general, adverse health effects that have been associated with exposure to EDB have resulted from exposure to concentrations that were much higher than those detected in City water supply system. Adverse non-cancer health effects are not expected as a result of exposure to EDB from the water system.

Cancer effects

The EPA classifies EDB as a Group B2 probable human carcinogen. This means that there is sufficient evidence of carcinogenicity in animal studies, but inadequate evidence in human epidemiological studies. Cancer risk is estimated by calculating an exposure dose (Appendix A) similar to that described above and multiplying it by a cancer potency factor, also known as the cancer slope factor. Some cancer potency factors are derived from human population data. Others are derived from laboratory animal studies involving doses much higher than are encountered in the environment. Use of animal data requires extrapolation of the cancer potency obtained from these high dose studies down to real-world exposures. This process involves much uncertainty.

Cancer Risk

Cancer risk estimates do not reach zero no matter how low the level of exposure to a carcinogen. Terms used to describe this risk are defined below as the number of excess cancers expected in a lifetime:

Term		# of Excess Cancers
low	is approximately equal to	1 in 10,000
very low	is approximately equal to	1 in 100,000
slight	is approximately equal to	1 in 1,000,000
insignificant	is less than	1 in 1,000,000

Current regulatory practice assumes that there is no “safe dose” of a carcinogen and that a very small dose of a carcinogen could give a very small cancer risk. Cancer risk estimates are, therefore, not yes/no answers but measures of chance (probability). Such measures, however uncertain, are useful in determining the magnitude of a cancer risk. The validity of the “no safe dose” assumption for all cancer-causing chemicals is not clear. Some evidence suggests that certain chemicals considered carcinogenic must exceed a threshold of tolerance before initiating cancer. For such chemicals, risk estimates are not appropriate. More recent guidelines on cancer risk from EPA reflect the potential that thresholds for some carcinogenesis exist. However, EPA still assumes no threshold unless sufficient data indicate otherwise.

This document describes cancer risk that is attributable to site-related contaminants in qualitative terms like low, very low, slight and no significant increase in cancer risk. These terms can be better understood by considering the population size required for such an estimate to result in a single cancer case. For example, a low increase in cancer risk indicates an estimate in the range of one excess cancer case per ten thousand persons exposed over a lifetime. A very low estimate might result in one excess cancer case per several tens of thousands exposed over a lifetime and a slight estimate would require an exposed population of several hundreds of thousands to result in a single case. DOH considers cancer risk insignificant when the estimate results in less than one cancer per one million exposed over a lifetime. The reader should note that these estimates are for excess cancers that might result in addition to those normally expected in an unexposed

population. Cancer risks quantified in this document are an upper-bound theoretical estimate. Actual risks are likely to be much lower.

EPA has derived a cancer potency factor based on these studies so that cancer risk to humans can be quantified. Cancer risk is the likelihood, or chance, of getting cancer. In a worst-case scenario, the current highest level of EDB in drinking water (0.5 ppb) would increase a person's cancer risk by 4 in 1,000,000 (4 excess cancers in a population of 1,000,000 people exposed) (See Appendix A - Table A3) and a lifetime cancer risk of 1 in 100,000. The reader should note that these estimates are for excess cancers that might result in addition to those normally expected in an unexposed population. This estimated risk is slight to very low.

Children's Health Concerns

The unique vulnerabilities of infants and children demand special attention in communities that have contamination of their water, food, soil, or air. The potential for exposure and subsequent adverse health effects often increases for younger children compared with older children or adults. ATSDR and DOH recognize that children are susceptible to developmental toxicity that can occur even when contaminant levels are much lower than those that cause other types of toxicity. This vulnerability is a result of the following factors:

- Children are more likely to play outdoors and bring food into contaminated areas.
- Children are shorter and their breathing zone is closer to the ground, resulting in a greater likelihood to breathe dust, soil, and heavy vapors.
- Children are smaller and receive higher doses of chemical exposure per body weight.
- Children's developing body systems are more vulnerable to toxic exposures, especially during critical growth stages in which permanent damage may be incurred.

During the evaluation of the City water supply, DOH considered potential exposures to children, as well as to adults. The doses calculated for EDB is not expected to result in adverse health effects for children, or adults, based on comparison with RfD value. The assessment did find that chronic exposure to EDB over many years (for example, 30 years) does indicate a very low to slight increased cancer risk.

Conclusions

No apparent public health hazard exists for residents exposed to EDB found in drinking water wells in the City.

Exposure to EDB at levels above the MCL can pose a very low to slight increase in cancer risk over many years of exposure. This estimate of cancer risk was based on worst-case assumptions such as the entire water source coming from contaminated Well No. 5 when in reality; Warden residents tend to drink water from Well No. 6. EDB has *not* been shown to cause cancer in humans, although studies of human populations are limited.

Recommendations

Although users of the City drinking water are not expected to experience adverse non-cancer health effects, and their increased cancer risk is very low to slight, the DOH Office of Drinking Water recommends quarterly testing for EDB in the City drinking water in order for the system to comply with the rules of the SDWA.

Public Health Action Plan

Action Completed

1. In December 2003, DOH Office of Drinking Water sent a letter and Public Notification to the City (See Appendix B).

2. DOH attended a City sponsored public meeting in Warden, Washington. Staff provided educational material to community members present at the meeting: DOH questions and answers sheet (See Appendix D).

Actions Planned

1. DOH will mail this consult to the City, GCHD and concerned residents of Warden.

2. DOH will evaluate future data if EDB concentrations in the City water system increase.

Other Actions

1. Ecology provided a grant to the City for the installation of packers in the affected wells. The packers are used to isolate the upper contaminated water-bearing zone from the lower, pumping zone. A packer has been installed on Well No. 5 and is currently being evaluated for effectiveness. A determination will be made either to install a second packer on Well No. 4 or to abandon the well.

2. Ecology will be leading an investigation to identify the source of the groundwater contamination.

3. The City will drill Well No. 2 about another 200 feet to make it a monitoring well.

4. Individuals who are concerned about their water supply can minimize exposure to EDB by taking precautionary measures such as limiting shower and bathing times, reducing the temperature of the bath water, and ensuring that bathrooms are well ventilated. Another option is to install a treatment system. If residents wish to install a home treatment device (e.g., under the sink models), the EPA states that granular activated carbon (GAC) is

considered the best available technology for treatment of EDB. Anyone considering the purchase of a GAC water treatment unit should make certain the system is listed by the National Sanitation Foundation (http://www.nsf.org/) for use in drinking water treatment, and that a third-party testing data confirms the unit is effective at removing EDB.

Questions or comments regarding Ecology's present or planned actions should be directed to Dave George at Ecology, Toxics Cleanup Program. Phone: (509) 329-3520; email: cgeo461@ecy.wa.gov

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1. Report on Groundwater Contamination that Affects Drinking Water in Washington State. Toxics Cleanup Program, Department of Ecology and Division of Drinking Water, Department of Health, April 1999. http://www.crcwater.org/issues7/19990419contamination.html

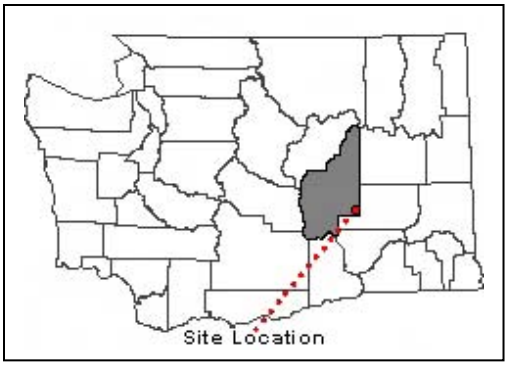
2. US Department of Health and Human Services, Agency for Toxic Substances and Disease Registry: Toxicological profile for 1,2-dibromomethane PB/93/110740/AS. Atlanta: US Department of Health and Human Services; July 1992.

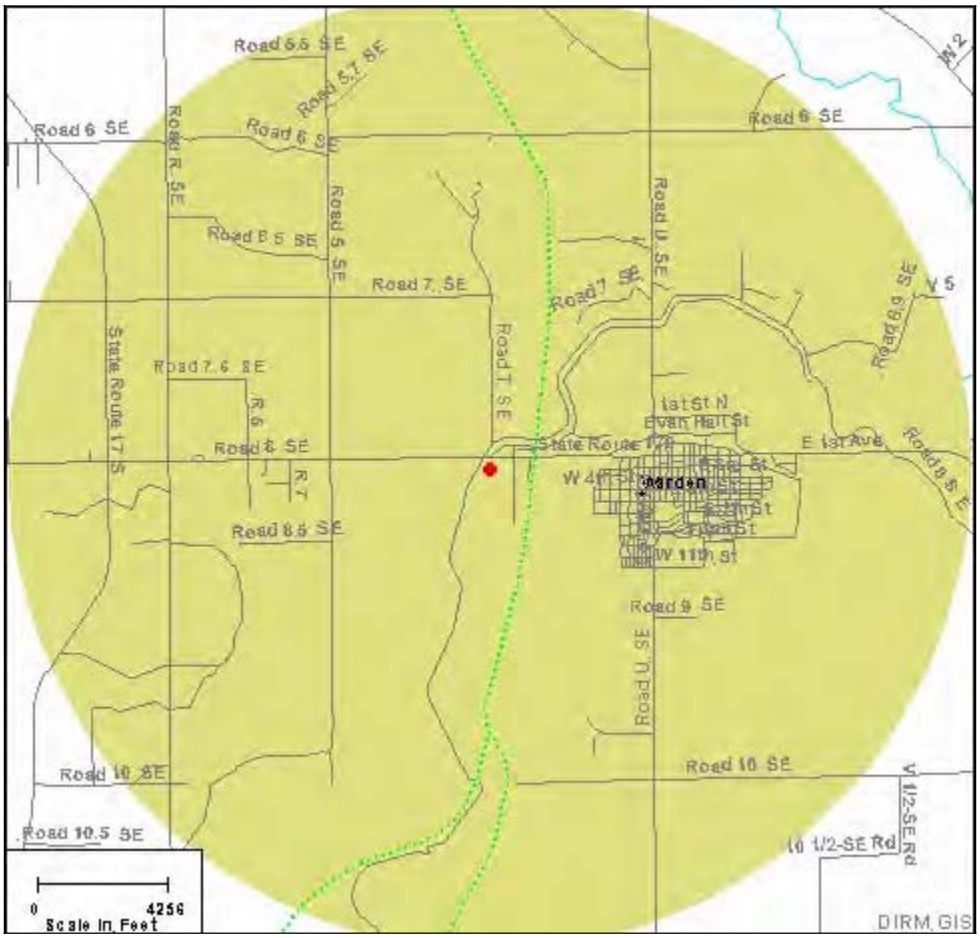
3. Foster, S.A. and Chrostowski, P.C. (1987) Inhalation Exposures to Volatile Organic Contaminants in the Shower. Presentation at the 80th Annual Meeting of APCA. New York, NY. June 21-26, 1987.

4. National Center for Environmental Assessment. Exposure Factors Handbook Volume 1 – General Factors EPA/600/P-95/002Fa: U.S. Environmental Protection Agency; August 1997.

Figure. 1: Demographic Statistics Within 3 Miles of the Site* - Warden area, Grant County, Washington.

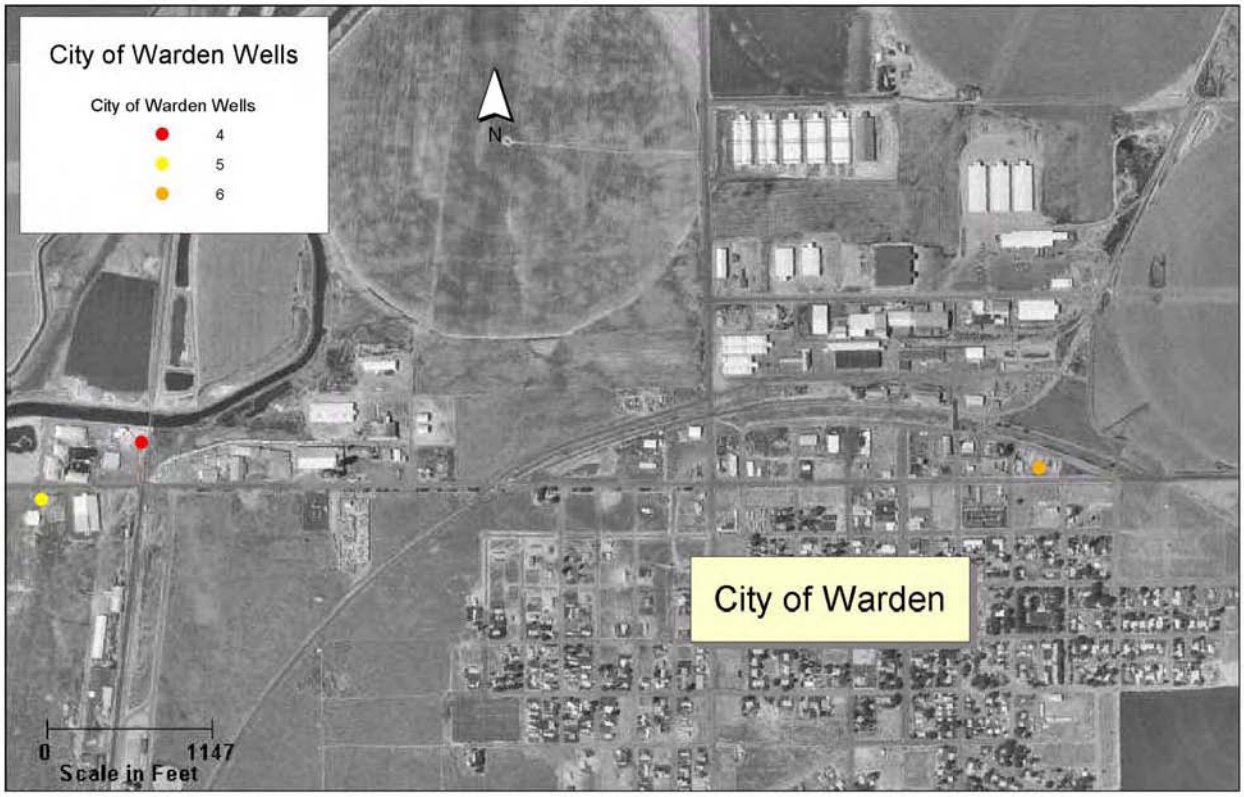
Total Population	**2941**
White	**1359**
Black	**5**
American Indian, Eskimo, Aleut	**25**
Asian or Pacific Islander	**16**
Other Race	**1451**
Hispanic Origin	**1930**
Children Aged 6 and Younger	**474**
Adults Aged 65 and Older	**216**
Females Aged 15 – 44	**623**
Total Aged over 18	**1800**
Total Aged under 18	**1142**
Total Housing Units	**921**





*** Calculated using the area proportion technique. Source: 2000 U.S. CENSUS**

Figure. 2: Arial photograph of Warden area, Warden, Washington, showing the city wells, July 16, 1995.



Appendix A

Exposure Calculations

This section provides calculated exposure doses and assumptions used for exposure to EDB in water from the City well. The following exposure parameters and dose equations were used to estimate exposure doses from ingestion, direct contact, and inhalation of EDB in water. The reader should be aware that maximum concentrations were used to calculate these doses in order to represent a worst-case scenario. This assumption may overestimate actual exposure, but it is intended to be protective of public health.

Three different receptor populations were considered when calculating non-cancer doses: children, older children, and adults. Cancer dose calculations assumed a 30-year exposure of a child growing to adulthood. Maximum air concentrations reached during a 20-minute shower were estimated using a mathematical model [3]. Use of maximum concentrations will likely over-estimate total shower inhalation exposure since maximum levels will not be present during the entire shower. This conservative approach was used to account for other sources of exposure such as clothes and dish washing that were not considered in the dose estimate. Dermal absorption during a 20-minute shower was estimated using EPA guidance.

Exposure to EDB in Water via ingestion, inhalation, and dermal absorption.

Total dose $_{\text{(non-cancer)}}$ = Ingested dose + inhaled dose + dermally absorbed dose

Ingestion Route

$$\text{Dose}_{\text{(non-cancer (mg/kg-day)}} = \frac{Cw \times CF \times IR \times EF \times ED}{BW \times AT_{\text{non-cancer}}}$$

$$\text{Cancer Risk} = \frac{Cw \times CF \times IR \times EF \times CSF \times ED}{BW \times AT_{\text{cancer}}}$$

Dermal Route - (Shower)

$$\text{Dermal Absorbed } (DA_{\text{event}}) = \frac{2 \times Kp \times Cw \times \text{SqR of } 6 \times \text{tau} \times t/\text{pi}}{\text{ORAF}}$$

$$\text{Dermal Absorbed Dose (DAD)}_{\text{(non-cancer (mg/kg-day))}} = \frac{DA_{\text{event}} \times EV \times SA \times EF \times ED}{BW \times AT_{\text{non-cancer}}}$$

$$\text{Dermal Absorbed Dose (DAD)}_{\text{(cancer (mg/kg-day))}} = \frac{DA_{\text{event}} \times EV \times SA \times EF \times ED \times CSF}{BW \times AT_{\text{cancer}}}$$

Inhalation Route – (Shower)

Concentration in air (Ca) = S/R x (1 – (EXP (-R x t))

$$Dose_{non\text{-}cancer\ (mg/kg\text{-}day)} = \frac{Ca \times IHR \times EF \times ED}{BW \times AT_{non\text{-}cancer}}$$

$$Cancer\ Risk = \frac{Ca \times IHR \times EF \times ED \times CSF}{BW \times AT_{cancer}}$$

Table A1. Exposure Assumptions for exposure to EDB in the City drinking water in Warden, Grant County, WA.

Parameter	Value	Unit	Comments
Concentration (Cw)	Variable	ug/l	Maximum detected value
Conversion Factor (CF)	0.001	ug/mg	Converts contaminant concentration from micrograms(ug) to milligrams (mg)
Ingestion Rate (IR) – adult	0.9	l/day	Exposure Factors Handbook [4]
Ingestion Rate (IR) – older child	1.0		
Ingestion Rate (IR) - child	1.4		
Exposure Frequency (EF)	350	days/year	Two weeks vacation
Exposure Duration (ED)	30 (5, 10,15)	years	Number of years at one residence (child, older child, adult yrs).
Body Weight (BW) - adult	72	kg	Adult mean body weight
Body Weight (BW) – older child	41		Older child mean body weight
Body Weight (BW) - child	15		0-5 year-old child average body weight
Surface area (SA) - adult	20000	cm^2	Exposure Factors Handbook [4]
Surface area (SA) – older child	11800		
Surface area (SA) - child	6640		
Averaging $Time_{non\text{-}cancer}$ (AT)	1825	days	5 years
Averaging $Time_{cancer}$ (AT)	27375	days	75 years
Cancer Slope Factor (CSF)	2	$mg/kg\text{-}day^{-1}$	Source: EPA
Event frequency (EV)	1	unitless	events/day
Oral route adjustment factor (ORAF)	1	unitless	Non-cancer (nc) / cancer (c) - default
Dermally absorbed dose per event (DA_{event})	Variable	mg/cm^2	Source: EPA
Dermally absorbed dose (DAD)	Variable	mg/kg-day	Source: EPA
Skin permeability coef. (Kp)	0.0033	cm/hr	Chemical specific
Lag time (tau)	1.2	hr	Chemical specific
Inhalation rate (IHR) - adult	0.21	m^3/day	Exposure Factors Handbook [4]
Inhalation rate (IHR) – older child	0.19		
Inhalation rate (IHR) - child	0.11		
Air exchange rate (R)	0.0083	min^{-1}	Model Parameters [3]
Time concentration calculated (t)	15	min	Model Parameters [3]
Concentration in air (Ca)	Variable	mg/m^3	Model Parameters [3]
S	Variable	mg/m^3-min	Model Parameters [3]

Table A2. Non-cancer hazard calculations resulting from exposure to EDB in the City drinking water in Warden, Grant County, WA.

Contaminant	Concentration (ppb) (ug/L)	Receptor population	Estimated Dose (mg/kg/day)			Total Dose	RfD (mg/kg/day)
			Ingestion	Dermal Contact	Inhalation		
EDB	0.5	Child	2.9E-5	1.1E-6	2.0E-7	3.0E-5	9 E-3
		Older child	1.2E-5	6.9E-7	1.3E-7	1.3E-5	
		Adult	9.3E-6	6.7E-7	7.8E-8	1.0E-5	

Table A3. Cancer risk resulting from exposure to EDB in the City drinking water in Warden, Grant County, WA.

Contaminant	Maximum Concentration (ppb)	EPA Cancer Group	Cancer Slope Factor ($mg/kg\text{-}day^{-1}$)		Receptor population	Cancer Risk			Total Cancer Risk
			Oral	Inhalation		Ingestion	Dermal Contact	Inhalation	
EDB	0.5	B2	2	2	Child	3.8E-6	1.4E-7	2.7E-8	3.97E-6
					Older child	3.1E-6	1.8E-7	3.4E-8	3.31E-6
					Adult	3.7E-6	2.7E-7	3.1E-8	4.00E-6

Lifetime cancer risk: 3.97E-6 + 3.31E-6 + 4.00E-6 = 1.13E-5

Appendix B: DOH letter and Public Notification to the City of Warden

December 19, 2003

Mike Thompson, City Administrator
City of Warden
P.O. Box 428
Warden, WA 98857

Re: Ethylene Dibromide (EDB) Public Notification
City of Warden PWS #92850Q - Grant Co.

Dear Mr. Thompson:

Attached for your use is a public notice for EDB. The requirement for public notification was triggered when the City of Warden violated the EDB maximum contaminant level (MCL) in samples collected from Well #5 during the period June through November 2003.

According to the Public Notification (PN) Rule, violating the EDB MCL is a "Tier 2" violation. A Tier 2 violation requires public notification within 30 days of learning that the MCL was violated. According to DOH records, the lab reported the most recent EDB sample result on December 1, 2003. Therefore, delivery of the EDB public notice must be made no later than January 1, 2004.

According to the PN Rule, the City must deliver a written copy of the public notice by mail or other direct delivery to each customer receiving a bill, and to post the notice at a location where a persons would not normally receive a bill, but that is regularly served by the water system (e.g., at schools, industrial sites, hospitals, nursing homes, office buildings, etc.).

You will note a suggestion to have the following statement translated into Spanish and positioned at the top of the attached public notice: Important! Take this to your community center to be translated or take this to someone who can translate it for you. If there is a Spanish translation service in the City, or at the Grant County Health District, then please reference the name and phone number of these available resources in the Spanish statement at the top of the notice.

If you should have any questions concerning this letter, please do not hesitate to contact me at the number shown below, or Jeff Johnson at (509) 456-2797.

Sincerely,

Scott Torpie, P.E.
Assistant Regional Office Manager
(509) 456-3183

cc: Grant Co. Health District
Jeff Johnson, DOH
Denise Clifford, DOH

Appendix C:

Notice to Water System Users
Ethylene Dibromide (EDB) Maximum Contaminant Level Exceeded

The City of Warden Water System, PWS ID No. 92850Q, located in Grant County, is reporting that water samples collected from one of its two active drinking water supply wells tested positive for Ethylene Dibromide (also known as EDB or 1,2 –Dibromoethane). Samples collected from Well #5 during the period June through November of this year have shown concentrations ranging from 61 to 92 parts per trillion (ppt). The state and federal drinking water standard, also known as the maximum contaminant level (MCL), is 50 parts per trillion (ppt).

State and federal drinking water regulations require the City to inform its customers that some people who drink water containing EDB in excess of the MCL over many years could experience problems with their liver, stomach, reproductive system, or kidneys, and may have an increased risk of getting cancer. The Department of Health (DOH) expects none of these human health problems to occur when EDB concentrations are at or below the MCL. When the MCL is violated, DOH requires that action be taken to assure that exposures will be reduced to levels that will not cause a health concern.

The exact cause of the EDB contamination is not known at this time. EDB is a colorless, heavy organic liquid with a mildly sweet chloroform-like odor. EDB was mainly used in Washington as a soil and grain fumigant (pesticide). Other uses of EDB include as an anti-knock agent in gasoline mixtures, as a solvent for resins, gums, and waxes; in waterproofing preparations; and in making dyes and drugs. In 1984, EPA banned its use as a soil and grain fumigant. EDB is a stable chemical compound that will last for a long time in the environment.

The City of Warden is working with the State Department of Health's Office of Drinking Water in evaluating the actions needed to bring the City's water supply back into compliance with federal and state drinking water standards. Until levels of EDB are consistently below the MCL, water samples from each of the City's active groundwater supply wells will be collected every three months and analyzed for EDB. In addition, a public notice will be published in the local newspaper and posted in public places throughout the City every three months, providing information regarding:

1. The recent concentration of EDB measured in each active water source;
2. recommendations, if any, for use of alternate water supplies and/or home treatment units, and;
3. steps being taken by the City to bring the water into compliance with state and federal drinking water standards.

Possible options for dealing with the EDB contamination include:

1. rehabilitating the contaminated well(s);
2. installing source treatment; and/or
3. the abandonment of the existing well(s) and construction of a new well(s).

While the above options are being considered by the City, consumers who wish to reduce their exposure to EDB may wish to consider the following:

1. purchase bottled water for drinking purposes; and/or
2. install granulated activated carbon (GAC) filters on showerheads, individual faucets, or at the point of entry to the home. The U.S. EPA states that granular activated carbon is considered best available technology for treatment of EDB. DOH recommends that these units be NSF or UL certified.

For more information about your drinking water, contact:

Mike Thompson, Warden City Manager (509) 349-2033
Warden City Hall
201 South Ash Street
Warden, WA 98857

Additional information about EDB can be found at the following websites:
http://www.atsdr.cdc.gov/tfacts37.html
http://www.atsdr.cdc.gov/es/toxfaqs/es_tfacts37.html (Spanish Version)

Please share this notice with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distribution copies by hand or mail.

This notice is sent to you by the City of Warden Water System on ___/___/____

Appendix D: DOH Question and Answer Sheet

Washington State Department of Health

January 2004

ENVIRONMENTAL HEALTH *Q & A*

City of Warden
Drinking Water and Ethylene Dibromide
Background

The City of Warden water system located in Grant County, has reported that one of the city's two active drinking water supply wells have tested positive for ethylene dibromide (also known as EDB or 1,2-dibromoethane). Samples collected from Well #5 during the period June through November of this year have shown concentrations ranging from 61 to 92 parts per trillion (ppt). EDB was also detected in he city's backup emergency well (Well # 4), which is not currently in use. The state and federal drinking water standard, also known as the maximum contaminant level (MCL), is 50 parts per trillion (ppt) for EDB.

The Department of Health (DOH) is working with the City of Warden to assure a safe and reliable drinking water supply. To that end, the City is required to develop a strategy that will bring water quality back into compliance with federal and state drinking water standards. Until levels of EDB are consistently below the MCL, water samples from each of the City's active groundwater supply wells will be collected every three months and analyzed for EDB. The results will be made available to the community.

Commonly Asked Questions

In addition to the public notice provided to customers by the City, the following information is intended to answer questions from the community.

Q: What is EDB?

Ethylene dibromide (EDB or 1,2-dibromoethane) was used extensively in the past as a soil fumigant pesticide and as a leaded-gasoline additive. EDB is a colorless, heavy organic liquid with a mildly sweet chloroform-like odor. EDB is a stable chemical compound that will last for a long time in the environment. The US Environmental Protection Agency (EPA) banned EDB for soil fumigation in 1984. This restriction along with a decline in the use of leaded gasoline has significantly reduced the amount of EDB used in the United States over the past two decades.

Q: Will the levels of EDB found in the City of Warden's drinking water affect my health?

It is not expected that exposure to the levels of EDB found in the Warden water system would make anyone sick in the short term. Immediate adverse effects associated with EDB exposure can only be expected at much higher levels than those detected in City of Warden water supply system. Standards that are used for EDB and other chemicals in drinking water are set below levels that have been shown to cause health problems. However, since EDB can cause adverse

effects, such as cancer, at higher levels when consumed over a long period, DOH and EPA require that action be taken at any level above the established standard. More information is available about the health effects of EDB from DOH, EPA and the Agency for Toxic Substances and Disease Registry (ATSDR).

Q: How does EDB in drinking water get into my body?
EDB enters the body when you drink the water, through the skin from activities like showering or bathing, or from breathing EDB vapors released from the water into indoor air. Drinking water with EDB is expected to contribute about half of the exposure with the rest coming during activities such as showering and bathing. Exposure during other household uses (e.g. cooking, clothes or dish washing) is expected to contribute only a small fraction of the total dose.

Q: How did EDB get into the city water wells?
At this time, the exact cause of the EDB contamination is not known. We do know EDB was used in Grant County prior to the 1984 EPA ban. It was used as a soil fumigant pesticide on crops such as potatoes. EPA banned the continued use of EDB partly because of the concern that it could contaminate ground water – even when used as directed. The Department of Health has seen EDB contamination of groundwater in other areas of the state and has learned to identify some of the more common risk factors associated with EDB contamination: These include:

1. The historical use of EDB in an area,
2. The presence of unprotected shallow groundwater that could become contaminated, and,
3. Vulnerable wells constructed in such a way that allow contaminated shallow groundwater to mix with deeper uncontaminated water.

In the case of Warden, all three factors apply. The two city wells that have detected EDB, are the oldest and although they are relatively deep, they have only been "cased" (lined) to a depth of less than 100 feet.

Q: Since EDB was found in two of the City's wells, how do you know it isn't in the third well?
The City has tested all of their wells and EDB was not found in Well # 6. This testing will continue and the city will report the results to the community as they work on a long- term solution. In addition, the construction of Well # 6 is different from Wells # 4 and #5. All of the wells are deep but unlike the other two wells, Well # 6 was built more recently and has been "cased" to a much deeper depth. That casing lines the drilled hole and helps to seal out any potential contaminants that might leak into to the well and contaminate the water.

Q: How widespread is the EDB contamination?
At this point, it is not known if the problem is local or more widespread. The positive samples from the city wells are what first alerted the DOH to the EDB contamination. While DOH's Office of Drinking Water works with the City to address its water quality problem, DOH's Office of Environmental Health Assessment will work with the Local Health Department, and the Department of Ecology to determine if there is a more extensive concern. That work will provide a better understanding of the possible sources and extent of the contamination. It will also consider actions the community might consider to reduce the overall long-term risk of exposure to EDB.

For further information, call or e-mail:

Jeff Johnson
Regional Engineer
Office of Drinking Water
Phone: 509-456-2797
Email: Jeff.Johnson@doh.wa.gov

Lenford O'Garro
Public Health Advisor
Office of Environmental Health Assessment
Phone: 360-236-3376
Email: Lenford.O'Garro@doh.wa.gov

Information is also available on the following websites:

EPA Consumer Fact Sheet on EDB:
http://www.epa.gov/safewater/contaminants/dw_contamfs/ethylene.html

ATSDR Frequently Asked Questions
http://www.atsdr.cdc.gov/tfacts37.html *(English Version)*
http://www.atsdr.cdc.gov/es/toxfaqs/es_tfacts37.html *(Spanish Version)*

Certification

This Health Consultation was prepared by the Washington State Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun. Editorial review was completed by the Cooperative Agreement partner.

Alan Parham
Technical Project Officer, CAT, SPAB, DHAC
ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

Team Lead, CAT, SPAB, DHAC
ATSDR