Health Consultation

1, 4 Dioxane Contamination in North Glen Water Association Well near Colbert Landfill NPL Site Colbert, Spokane County, Washington EPA FACILITY ID: WAD980514541

May 24, 2006

Prepared by:
Washington State Department of Health
under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Washington State Department of Health

DOH 334-103 May 2006

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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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 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 2005, Spokane County Utilities (SCU) collected groundwater samples in the Colbert Landfill area and the North Glen Residential Community well system (North Glen). Results indicated the presence of 1,4-dioxane, and SCU notified the Washington State Department of Health (DOH) Office of Drinking Water. DOH has prepared this health consultation at the request of the Spokane Regional Health District (SRHD) to evaluate the potential health hazard posed by the 1,4-dioxane found in the North Glen Residential Community well system (North Glen). DOH prepares public health consultations (PHC) under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

Background

North Glen Water System

The North Glen Community well system (North Glen) is located adjacent to Colbert Landfill site. North Glen is a Group A residential water system with 34 connections that is approved for up to 150 connections. The Colbert Landfill site is a closed 40-acre municipal solid waste landfill located approximately 15 miles north of Spokane, Washington, and about 2.5 miles north of Colbert, Washington [1, 2]. In August 1983, the Environmental Protection Agency (EPA) placed the Colbert landfill on its National Priorities List (NPL). In 1987, a Remedial Investigation/Feasibility Study (RI/FS) was conducted to determine the nature and extent of contamination caused by the release of chemicals from the landfill and to evaluate potential remedies. Six chlorinated organic solvents (1,1,1-Trichloroethane (TCA), Methylene Chloride, 1,1-Dichloroethylene, Trichloroethylene, Tetrachloroethylene and 1,1-Dichloroethane) were detected in the groundwater near the landfill [2]. The RI/FS recommended a pump and treat system (treatment facility) which came online in May 1994.

In 2004, during the most recent five year review of the Colbert Landfill site, EPA requested that SCU monitor for the possible presence of a newly found groundwater contaminant known to be associated with TCA [1]. The contaminant, called 1,4-dioxane, was commonly added as a stabilizer to solvents such as TCA.

On July 20, 2005, SCU collected seven groundwater samples in the Colbert Landfill area from various types of wells (such as extraction, monitoring and residential).1,4-dioxane was detected in three wells at levels between and 6.3 and 25.8 parts per billion (ppb), but not in the remaining four wells at a method detection level of 5.0 ppb. The samples with 1,4-dioxane concentrations represented North Glen (11.3 ppb), an upper aquifer extraction well (25.8 ppb) and a lower aquifer extraction well (6.3 ppb). The concentration found in North Glen is above the Washington State Model Toxics Control Act (MTCA) Method B clean-up level of 7.95 ppb and the state's groundwater standard of 7.0 ppb.

Follow-up sampling on September 14, 2005, of five residential wells adjacent to the landfill detected 1,4-dioxane only in North Glen's water (11.1 ppb). The other four wells showed no evidence of 1,4-dioxane contamination. Two of three environmental monitoring wells adjacent to North Glen showed 1-4-dioxane levels of 8.8 ppb and 23.9 ppb. Two extraction wells for the treatment facility contained 1,4-dioxane at concentrations of 11.1 ppb to 30 ppb. As of October 5, 2005, a total of 32 residential wells in the Colbert landfill area have been sampled and North Glen is the only drinking water system to show the presence of 1,4-dioxane.

Table 1. Concentration of 1,4-dioxane detected in North Glen's water association drinking water Well, Colbert, Spokane County, Washington.

Source	1, 4 Dioxane		EPA Cancer Class
	Date Sampled	Results (ppb)	
North Glen	10/05/05	13.8	B2
	9/14/05	11.1	
	7/20/05	11.3	

Discussion

1,4-Dioxane was found in North Glen drinking water supply well (Table.1). Its presence alone does not necessarily indicate that adverse health effects will occur. 1,4-Dioxane is a clear liquid that is miscible in water. It is used primarily as a solvent in the manufacture of chemicals and as a laboratory reagent [3]. 1,4-dioxane, was commonly added as a stabilizer to solvents such as TCA. In the 1970s, municipal water supplies in the United States were reported to contain 1 ppb of 1,4-dioxane [3]. 1,4-Dioxane has also been detected in food volatiles (chicken, meat, tomatoes, and small shrimp) which may indicate that 1,4-dioxane may be a natural constituent in some foods [3]. 1,4-Dioxane may also be found as a contaminant in cosmetics, detergents and shampoos. Therefore, in 1985, the Food and Drug Administration (FDA) required cosmetic products should not contain 1,4-dioxane at concentrations greater 10 ppm. Between 1992 and 1997, the average concentration of 1,4-dioxane in cosmetic finished products was to reported fluctuate from 14 to 79 ppm [3].

Exposure to 1, 4-Dioxane in water

1,4-dioxane is very soluble in water. Therefore, the most obvious route of exposure to 1,4-dioxane in drinking water is ingestion. However, 1,4-dioxane is easily metabolized in the body to form β-hydroxyethoxyacetic acid, which is then eliminated from the body in urine. 1,4-dioxane also has a low volatility in water and is therefore available for inhalation from indoor air particularly during bathing and showering. Exposure to 1,4-dioxane through these routes and pathways is evaluated below.

Non-cancer effects

In order to evaluate the potential for non-cancer adverse health affects that may result from exposure to 1,4-dioxane in water, a dose is estimated for each route of exposure (ingestion, dermal, and inhalation). These doses are estimated 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.

ATSDR's minimal risk level (MRL) for 1,4-dioxane was the health guideline chosen to evaluate potential exposures from drinking water. MRLs 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 MRL.

The chronic oral MRL for 1,4-dioxane is 0.01 mg/kg/day based on liver effects in male rats. Other non-cancer health effects associated with 1,4-dioxane exposure are problems with the kidneys damage, eye, throat and nose irritation [3]. These health effects occurred in animal studies after exposure to very high levels of 1,4-dioxane.

People who are users of water from North Glen may be exposed through multiple routes and pathways. 1,4-Dioxane can enter the body through ingestion of drinking water, through the skin during bathing and through inhalation during showering. Exposure doses were calculated for people exposed through all pathways. Exposure equations and assumptions are provided in Appendix A, Table A1. This PHC assumes people are exposed everyday for five years to the maximum level measured in the well (13.8 ppb). The highest estimated exposure dose was 7.96 x 10^{-4} mg/kg/day and is below the MRL (1.0 E-2 mg/kg/day). Breathing 1,4-dioxane 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). Therefore, exposure to water from the well 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 1,4-dioxane have resulted from exposure to concentrations that were much higher than those detected in water supply system. Adverse non-cancer health effects are not expected as a result of exposure to 1,4-dioxane from the water system.

Cancer effects

The EPA classifies 1,4-dioxane 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.

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.

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

In a worst-case scenario, exposure to the current highest level of 1,4-dioxane in drinking water (13.8 ppb) would increase a person's lifetime cancer risk by 2 in 1,000,000 (2 excess cancers in a population of 1,000,000 people exposed) (See Appendix A - Table A3). 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, and within the range of cancer risks considered acceptable by the EPA.

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 smaller and receive higher doses of chemical exposure per body weight.
- Children's developing bodies or systems are more vulnerable to toxic exposures, especially during critical growth stages in which permanent damage may incur.

During the evaluation of the water supply, DOH considered potential exposures to children, as well as to adults. The doses calculated for 1,4-dioxane is not expected to result in adverse health effects for children, or adults, based on comparison with MRL value. The assessment did find that chronic exposure to 1,4-dioxane over many years (for example, 30 years) does indicate a slight increased cancer risk.

Conclusions

No apparent public health hazard exists for residents exposed to 1,4-dioxane found in drinking water well for North Glen.

Recommendations

Although users of North Glen drinking water are not expected to experience adverse non-cancer health effects, and their increased cancer risk is slight. The DOH Office of Environmental Health Assessments recommends SCU continue to monitor the level of contaminants in the groundwater from the Colbert Landfill and 1,4-dioxane in North Glen's water system.

Public Health Action Plan

Actions Completed

1. In September 2005, SCU sent a letter and Public Notification to the residents of North Glen.
2. DOH Office of Drinking Water staff attended a SCU sponsored public meeting in Colbert, Washington.

Actions Planned

1. DOH will mail this consult to the SCU, SRHD and residents of North Glen.
2. DOH will evaluate future data if 1,4-dioxane concentrations in the water system increase.

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References

1. Five-Year review report, Third five-year review report for Colbert Landfill, Spokane County, Washington: Prepared by Spokane County, Department of Ecology and Environmental Protection Agency, Region 10; August 2004.

2. US Department of Health and Human Services, Agency for Toxic Substances and Disease Registry: Public Health Assessment for Colbert Landfill NPL Site, Spokane, Washington, CERCLIS No. WAD980514541, July 25, 1988.

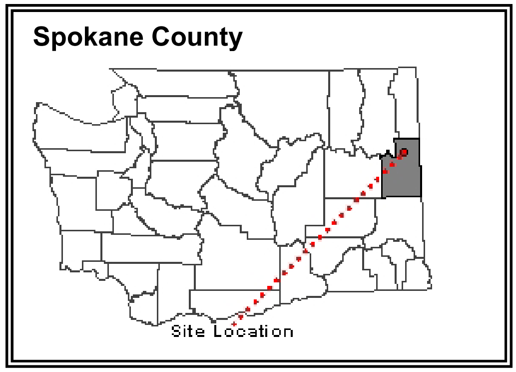
3. US Department of Health and Human Services, Agency for Toxic Substances and Disease Registry: Toxicological profile for 1,4-dioxane (*Draft for Public Comment*). Atlanta: US Department of Health and Human Services; September 2004.

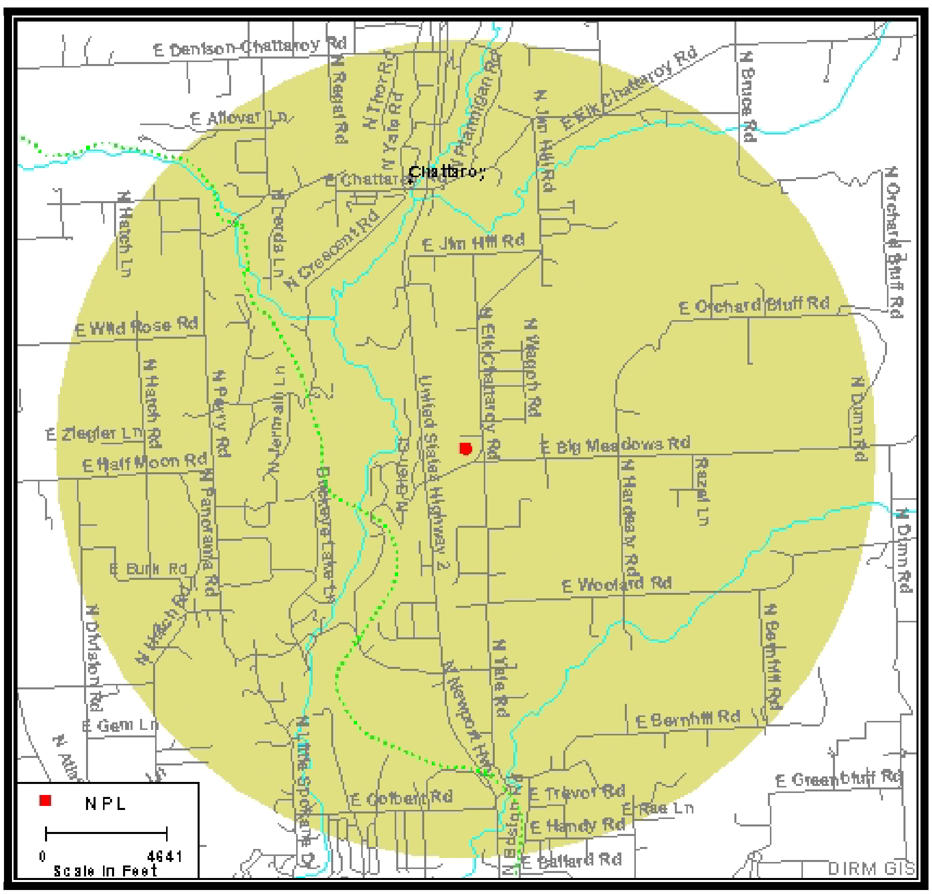
4. Foster, S.A. and Chrostowski, P.C. (1987) Inhalation Exposures to Volatile Organic Contaminants in the Shower. Presentation at the 80th Annual Meeting of APCA. New York, NY. June 21-26, 1987.

5. 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* - Colbert landfill area, Spokane County, Washington.

Total Population	**3509**
White	**3399**
Black	**4**
American Indian, Eskimo, Aleut	**30**
Asian or Pacific Islander	**17**
Other Race	**10**
Hispanic Origin	**49**
Children Aged 6 and Younger	**265**
Adults Aged 65 and Older	**332**
Females Aged 15 – 44	**699**
Total Aged over 18	**2484**
Total Aged under 18	**1025**
Total Housing Units	**1242**





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

Appendix A

Exposure Calculations

This section provides calculated exposure doses and assumptions used for exposure to 1,4-dioxane in water from the North Glen. The following exposure parameters and dose equations were used to estimate exposure doses from ingestion, direct contact, and inhalation of 1,4-dioxane 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 [4]. 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

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

$$\text{Cancer Risk} = \frac{\text{Cw x CF x IR x EF x CSF x ED}}{\text{BW x AT}_{\text{cancer}}}$$

Dermal Route - (Shower)

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

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

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

Inhalation Route – (Shower)

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

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

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

Table A1. Exposure Assumptions for exposure to 1,4-dioxane in North Glen drinking water in Colbert, Spokane 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 [5]
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 [5]
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)	0.00036	cm/hr	Chemical specific
Lag time (tau)	0.3	hr	Chemical specific
Inhalation rate (IHR) - adult	0.21	m^3/day	Exposure Factors Handbook [5]
Inhalation rate (IHR) – older child	0.19		
Inhalation rate (IHR) - child	0.11		
Air exchange rate (R)	0.0083	min^{-1}	Model Parameters [4]
Time concentration calculated (t)	15	min	Model Parameters [4]
Concentration in air (Ca)	Variable	mg/m^3	Model Parameters [4]
S	Variable	mg/m^3-min	Model Parameters [4]

Table A2. Non-cancer hazard calculations resulting from exposure to 1,4 dioxane in North Glen drinking water in Colbert, Spokane County, WA.

Contaminant	Concentration (ppb) (ug/L)	Receptor population	Estimated Dose (mg/kg/day)			Total Dose	MRL (mg/kg/day)
			Ingestion	Dermal Contact	Inhalation		
1,4 Dioxane	13.8	Child	7.9E-4	1.6E-6	3.9E-6	7.96E-4	1.0 E-1
		Older child	3.2E-4	1.0E-6	2.4E-6	3.23E-4	
		Adult	2.6E-4	1.0E-6	1.5E-6	2.63E-4	

Table A3. Cancer risk resulting from exposure to 1,4 dioxane in North Glen drinking water in Colbert, Spokane County, WA.

Contaminant	Maximum Concentration (ppb)	EPA Cancer Group	Cancer Slope Factor (mg/kg-day^{-1})	Receptor population	Cancer Risk			Total Cancer Risk
					Ingestion	Dermal Contact	Inhalation	
1,4 Dioxane	13.8	B2	0.011	Child	5.8E-7	1.2E-9	2.8E-9	5.84E-7
				Older child	4.7E-7	1.5E-9	3.5E-9	4.75E-7
				Adult	5.7E-7	2.2E-9	3.2E-9	5.75E-7

Lifetime cancer risk: 5.84E-7 + 4.75E-7 + 5.75E-7 = 1.63E-6

Certification

This North Glen Health Public 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.

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

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