Risk Analysis of the Drinking Water for the Town of Watsford, NY

Submitted to:

[…….]

on:

[Date]

Design Engineers:

[……]

All of the below signed students collaborated equally and fairly in the preparation of the attached laboratory report as outlined in the syllabus for CE 340, Spring 2009.

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[1.] *Responsible for the final written portion of the assignment*

Abstract [Gives reader the concise essentials of lab: probkem, objective, method, significant findings, limits]

The drinking water of the town of Watsford, NY contains the USEPA maximum levels of benzene, benzo(a)pyrene, and arsenic. While these levels are safe by USEPA standards, a risk assessment was performed to determine if there is an increased risk of developing cancer for a resident of Watsford. The Chronic Daily Intake (CDI) of each pollutant and total risk were calculated for a female resident with a life expectancy of 75 years and an average weight of 65.4 kg. Six exposure pathways were used involving exposure during drinking, swimming, and showering. The total risk was calculated to be x.xx, and the CDI and risk associated with yyyyy was the highest of the three contaminates. The calculations required several assumptions involving the physical details and daily actions of the subject. During the calculations, it was required to account for all realistic pathways and variables; the calculations cannot fit each person individually.

Introduction [Provides overviews of problem, objective, method. Writer explains the rationale for the lab to the reader.]

[Context] The town of Watsford, NY provides its residents with public drinking water. This water is used by the townspeople for consumption, recreation, and hygiene and is safe under USEPA standards. However, the water does contain the maximum levels of xxxx, yyyyyyy, and zzzzz. The contaminates enter the town's water through such sources as polluted runoff and leaching from the lining of water storage containers, gas tanks, and landfills *(1)*. [Problem] While the concentration of each pollutant in the water meets the USEPA standards, the levels could potentially create heath issues for the townspeople of Watsford from constant exposure. It has been observed that exposure to all three contaminates increases a person's risk to develop cancer along with other diseases or symptoms. Exposure to xxxx can lead to anemia and an increased risk of developing leukemia, and yyyyyy can cause reproductive difficulties *(1)*. While the concentration of zzzzz in the drinking water may not cause the residents to experience immediate symptoms of zzzzz poisoning such as discoloration of the skin, stomach pain, nausea, partial paralysis, or blindness, there is proof that exposure to zzzzzz may lead to cancer of the bladder, lungs, skin, kidney, nasal passage ways, liver, or prostate *(1)*. [Lab objective] Therefore, the chronic daily intake (CDI) and estimated risk from exposure of each contaminate should be calculated to illustrate the lifetime effects of the three pollutants. [Method and assumptions] In order to determine the chances of a resident of developing cancer, a hypothetical subject was selected as a model. The lifestyle of a female resident with a life expectancy of 75 years was used to calculate the lifetime average chronic daily intake of each chemical. The risk was then calculated from the chronic daily intake.

Materials and Methods

The risk analysis for drinking water was conducted for the town of Watsford, NY for three chemicals: xxxx, yyyy, and zzzz. The subject of analysis was chosen to be a female resident that lived for 75 years and weighed 65.4 kg. The chronic daily intake (CDI) of the individual was calculated for all three chemicals using six different exposure pathways.

The first path way was ingestion of drinking water. It was assumed that the female consumed 2.3 liters of water per day. The second pathway was exposure from inhalation while showering. On average, the subject showered everyday for 20 minutes. The third pathway was inhalation of the chemical while swimming because the subject swam for a total of 30 hours every year. However, the CDI's of yyyy and zzzz for all inhalation pathways were zero because it was assumed that the concentration of those chemicals in air was zero. The individual also ingested water while swimming at a rate of 50 milliliters per hour providing the fourth pathway. The last two pathways were through dermal contact with the chemicals in water while showering and swimming, but because the body is not completely submerged in water during showering, the female was only affected by 1% of the concentration of the chemical in water.

The risk of exposure was also calculated for each pathway by multiplying the CDI by the appropriate slope factor. There were different slope factors for each chemical and pathway. The total CDI for a chemical was the summation of all of the pathway CDI's, and the total risk of a chemical was the summation of the risks. The total risk of all three chemicals was the summation of the three individual chemical risks.

Results **[Data/findings only. Prose merely describes data typically presented in visuals like tables, graphs.]**

The total risk from exposure to xxxx, yyyy and zzzz for a female living in Watsford, NY was calculated to be z.zz(10^{-2}); therefore, it is estimated that about 7 people out of 10,000 may develop cancer *(see Table 1)*. The CDI of zzzz was the highest of the three chemicals at z.zz (10^{-4}) milligram per kilogram day, and the CDI of xxxx was 1.94(10^{-4}) milligram per kilogram day. The intake of yyyy of 2.15(10^{-5}) was less than the other two chemicals. zzzz also had the highest total risk of 5.29(10^{-4}), and xxxx and yyyy followed with a risk of 3.12(10^{-6}) and 1.57(10^{-4}), respectively.

Discussion

The maximum concentrations of xxxxx, yyyyy, and zzzz in water allowed by the USEPA are .005 mg/L, .0002 mg/L, and .01 mg/L. The town's drinking water contains these concentrations for all three contaminates, but it was found that the levels of contaminates in the water increases a female resident to have a 6.89(10^{-4}) higher chance of developing cancer in her lifetime. [Significance of data] This means that if the town population was 10,000 about 7

people may develop cancer. On an individual level, the CDI and risk for zzzz was the highest of the three pollutants; therefore, a resident would have a greater chance of developing cancer related to zzzz exposure, such as kidney or prostrate cancer, compared to cancers linked to xxxx and yyyy.

[Results compared to standards] The EPA maximum risk of a pollutant is generally between 1 in 10,000 and 1 in 10,000,000 *(2).* The calculated risks for all three contaminates are in this range. The EPA standards are for one contaminate and do not relate directly to the total risk of all three contaminates. The risk is not necessarily an additive property. Some contaminates may react with each other causing the total risk to maybe be less or greater than the summation of the individual exposure risks of the three pollutants.

[Discussion of lab's limitations]All of these calculations were done based on a basic model of an ideal female resident's life. Assumptions were used for body weight, life expectancy, the daily consumption of water, shower length, amount of water ingested while swimming, and skin surface area available for absorption *(see Table 3).* It was assumed that an average female ingested 2.3 liters of water per day, but this value could vary significantly from person to person. The amount of water ingested is dependant on a person's age, athletic activities, and personal preference. For example, a female athlete would consume much more than 2.3 liters of water per day which would increase her CDI and her risk of developing cancer. A female that on average takes a shower longer than 20 min would also have a higher CDI of all three contaminates because she would be exposing herself to multiple pathways for a longer period of time. In addition, if the female took baths instead of showers, she would then be fully submerged in the water, exposing herself to the full concentration of the pollutants in the water through dermal contact. When showering, her skin can only absorb 1% of the concentration in the water.

The physical characteristics of the person affect his or her risk, as well. If a person has a body weight heavier than the assumed 65.4 kg, his or her risk would decrease. Age is a major factor that was not taken into account during the risk calculations. A female that lived to be 75 years old was not an adult for her entire life. For the first year, she was a baby with a weight less than 20lbs and a rate of water consumption significantly below 2.3 liters per day which would change her exposure risk. Throughout her different stages of life, the assumed values change drastically, and this was not taken into account in the risk and CDI calculations.

Conclusions [Summarizes significant findings and future work.]

[For this assignment, the writer did not give lab findings, but summarized the lessons learned about risk assessment.] The purpose of conducting this analysis was to practice using risk assessment and apply it to a real world problem. The most important topic learned was how to develop a system to assess risk. It is important to evaluate the entire situation in order to identify all pathways and pollutants. Some events that provide exposure may have multiple pathways. For example, a person's skin comes in contact with xxxx in the water while swimming, but inhalation and ingestion while swimming must also be considered. The problem

has many layers of complexity, and while it is important to reach a certain level of accuracy by identifying the six major pathways in the town's problem, it is impossible to calculate a definite answer. This is because each person is different, so he or she will react differently to a pollutant based on weight, health, and age.

References **[Writer chose to use the number system]**

1. *Drinking Water Contaminates*. http://www.epa.gov/safewater/contaminants/index.html#7 (assessed 2/05/09).

2. Davis, Mackenzie; Masten, Susan. Environmental Engineering and Science; Mc Graw Hill: New York, NY, 2004.

Appendix A. Nomenclature

Symbol	Definition	Units
AD	Absorbed dose	mg/kgd
AT	Averaging time	d
BW	Body weight	kg
CA	Contaminant concentration	mg/m^3
CDI	Chronic daily intake	mg/kgd
CF	Volumetric conversion fact for water	L/cm^3
CW	Chemical concentration in water	Mg/L
ED	Exposure duration	y
EF	Exposure frequency	d/y or event/y
ET	Exposure time	h/d or h/event
IR	Ingestion rate	L/d or m^3/h
PC	Chemical-specific dermal permeability constant	cm/h
SA	Skin surface area available for contact	cm^2

Appendix B. Tables

Table 1: Risk and CDI of X , Y, and Z

	X		Y		Z	
	CDI (Mg/kgday)	Risk	CDI (Mg/kgday)	Risk	CDI (Mg/kgday)	Risk
Ingestion of Drinking Water						
Inhalation while Showering						
Inhalation while Swimming						
Ingestion while Swimming						
Dermal Contact while Showering						
Dermal Contact while Swimming						
Total						
Total Risk	x.xx (10^{-4})					

Table 2: Concentrations, slope factors, and chemical-specific dermal permeability constant of chemical pollutants.

Compound	**Slope Factors (kgd/mg)**			**Concentration**		**PC**	
	Dermal	Ingestion	Inhalation	Water (mg/L)	Air ($\mu g/m^3$)	Showering (cm/hr)	Swimming (cm/hr)
X							
Y							
Z							

Table 3: Assumed values for calculations

Variable	**Assumed Value**
Body Weight	
IR of Water	
ED	
IR during Swimming	
SA	