Appendix C:

Exposure Calculations

Appendix C

Exposure Calculations:

Past Exposures:

Non-Cancerous:

Ingestion Exposure for TCE in drinking water:

$$\text{Ingestion Exposure Dose} = \frac{C \times IR \times EF}{BW}$$

Where:
C = contaminant concentration in mg/L (example - 25 ppb = 0.025 ppm or mg/L)
IR = ingestion rate
EF = exposure factor (calculations considers complete absorption of contaminants)
BW = body weight in Kilograms

Adult using water from the Oak Grove Village Public Water System:
Calculations for adults assumes that they weigh 70 Kg and drinks 2 Liter (L) of tap water per day.

$$\text{Ingestion Exposure Dose} = \frac{0.025 \text{ TCE mg/L} \times 2 \text{ L/day water} \times 1}{70 \text{ Kg}} =$$

Adult Ingestion Exposure Dose = 0.0007 mg/Kg/day

Child using water from the Oak Grove Public Water System:
Calculations for children assume that they weigh 10 Kg and drinks 1 L of tap water per day.

$$\text{Ingestion Exposure Dose} = \frac{0.025 \text{ TCE mg/L} \times 1 \text{ L/day water} \times 1}{10 \text{ Kg}} =$$

Child Ingestion Exposure Dose = 0.0025 mg/Kg/day

Adult using water from contaminated private well (highest known contaminant level):

$$\text{Ingestion Exposure Dose} = \frac{0.0164 \text{ TCE mg/L} \times 2 \text{ L/day water} \times 1}{70 \text{ Kg}} =$$

Adult Ingestion Exposure Dose = 0.00047 mg/Kg/day

Child using water from contaminated private well (highest known contaminant level):

$$\text{Ingestion Exposure Dose} = \frac{0.0164 \text{ TCE mg/L} \times 1 \text{ L/day water} \times 1}{10 \text{ Kg}} =$$

Child Ingestion Exposure Dose = 0.00164 mg/Kg/day

Total Exposure for TCE in Drinking Water (Ingestion and Inhalation Exposure)

Because the user of a TCE contaminated water supply would also have exposure through inhalation as TCE volatilizes into the air, inhalation exposure must be included as part of the exposure. Most of this inhalation exposure takes place during and after showering as time spent in the bathroom. To consider both pathways of exposure and their additive effect, we double (x 2) the ingestion exposure dose for a conservative (more protective) value to include both pathways.

Using TCE Contaminated Oak Grove Village Public Water
Total Adult Exposure Dose = 0.0007 mg/Kg/day x 2 = 0.0014 mg/Kg/day

Total Child Exposure Dose = 0.0025 mg/Kg/day x 2 = 0.0050 mg/Kg/day

Using TCE Contaminated Private Well
Total Adult Exposure Dose = 0.00047 mg/Kg/day x 2 = 0.00094 mg/Kg/day

Total Child Exposure Dose = 0.00164 mg/Kg/day x 2 = 0.0033 mg/Kg/day

ATSDR's Acute (14 days or less) ingestion MRL for TCE = 0.2 mg/Kg/day
ATSDR has not derived an intermediate (15–364 days) ingestion exposure MRL for TCE
ATSDR has not derived a chronic (365 days or more) ingestion exposure MRL for TCE

Cancer:

Using the assumption that TCE is carcinogenic, even though it is under review as to its carcinogenicity, the following calculation is used to approximate its theoretical risk if it would be determined to be carcinogenic in humans.

Formula:

$$\text{Cancer Risk} = \frac{\text{Exposure dose x risk factor x years of exposure}}{\text{70 years (lifetime)}}$$

Cancer Risk using TCE Contaminated Oak Grove Village Public Water

(Risk factor = 0.4 (EPA's Oral Slope Factor))

$$\textbf{Adult Cancer Risk} = \frac{0.0014 \text{ mg/Kg/day} \times 0.4 \text{ (mg/Kg/day)}^{-1} \times 6.5 \text{ years}}{70 \text{ years}} =$$

$$\textbf{Adult Cancer Risk} = 0.000052 = 52 \times 10^{-6} = 5.2 \times 10^{-5}$$

$$\textbf{Child Cancer Risk} = \frac{[0.0050 \text{ mg/Kg/day} \times 0.4 \text{ (mg/Kg/day)}^{-1} \times 6 \text{ years}] + [0.0014 \text{ mg/Kg/day} \times 0.4 \text{ (mg/Kg/day)}^{-1} \times 0.5 \text{ years}]}{70 \text{ years}} =$$

$$\textbf{Child Cancer Risk} = \frac{[0.012] + [0.00028]}{70} = 0.000175 = 175 \times 10^{-6} = 1.75 \times 10^{-4}$$

(Note: Child is considered 1 – 6 years old, full six years are used for calculations)

Cancer Risk Using TCE Contaminated Private Well (Maximum level and time)

(Risk factor = 0.4 (EPA's Slope Factor))

Adult Cancer Risk = $\frac{0.00094 \text{ mg/Kg/day} \times 0.4 \text{ (mg/Kg/day)}^{-1} \times 14 \text{ years}}{70 \text{ years}} =$

Adult Cancer Risk = 0.0000752 = 75.2 x 10^{-6} = 7.52 x 10^{-5}

Child Cancer Risk =

$= \frac{[0.0033 \text{ mg/Kg/day} \times 0.4 \text{ (mg/Kg/day)}^{-1} \times 6 \text{ years}] + [0.00094 \text{ mg/Kg/day} \times 0.4 \text{ (mg/Kg/day)}^{-1} \times 8 \text{ years}]}{70 \text{ years}} =$

Child Cancer Risk $= \frac{[0.00792] + [0.0030]}{70} =$ **0.000156 = 156 x 10^{-6} = 1.56 x 10^{-4}**

(Note: Child is considered 1 – 6 years old, full 6 years are used for calculations)

Future Potential Exposures:

Non-Cancerous:

The following are calculations of the expected exposure to the Oak Grove Village public water system user if the village restarts their existing contaminated well until a new well can be dug and placed into operation. The expected time is two years for the new well to be placed into service. The actual level of TCE contamination in the village well under actual pumping conditions is not presently known and will not be known until the well is tested under actual pumping conditions. Sampling is planned by MDNR in the near future to determine the actual TCE level under pumping conditions. For calculation purposes, the last known maximum level of TCE detected under actual pumping conditions (42 ppb in 1997) when the well was pumped for 20 minutes before sampling will be used.

Ingestion Exposure to TCE from restarting old Oak Grove Village well:

$$\text{Ingestion Exposure Dose} = \frac{C \times IR \times EF}{BW}$$

Where:
C = contaminant concentration in mg/L (example - 42 ppb = 0.042 ppm or mg/L)
IR = ingestion rate
EF = exposure factor (calculations considers complete absorption of contaminants)
BW = body weight in Kilograms

Adult:
Calculations for adults assumes that they weigh 70 Kg and drinks 2 Liter (L) of tap water per day.

$$\text{Ingestion Exposure Dose} = \frac{0.042 \text{ TCE mg/L} \times 2 \text{ L/day water} \times 1}{70 \text{ Kg}} =$$

Ingestion Exposure Dose = 0.0012 mg/Kg/day

Child:
Calculations for children assume that they weigh 10 Kg and drinks 1 L of tap water per day.

$$\text{Ingestion Exposure Dose: } \frac{0.042 \text{ TCE mg/L} \times 1 \text{ L/day} \times 1}{10 \text{ Kg}} =$$

Ingestion Exposure Dose: 0.0042 mg/Kg/day

Total Exposure for TCE in Drinking Water (Ingestion and Inhalation Exposure)

Again, because the user of a TCE contaminated water supply would also have exposure through inhalation as TCE volatilizes into the air, inhalation exposure must be included as part of the exposure. Most of this inhalation exposure takes place during and after showering as time spent in the bathroom. To consider both pathways of exposure and their additive effect, we double the (x 2) ingestion exposure dose for a conservative (more protective) value to include both pathways.

Total Adult Exposure Dose = 0.0012 mg/Kg/day x 2 = 0.0024 mg/Kg/day

Total Child Exposure Dose = 0.0042 mg/Kg/day x 2 = 0.0084 mg/Kg/day

ATSDR's Acute (14 days or less) ingestion MRL for TCE = 0.2 mg/Kg/day
ATSDR has not derived an intermediate (15–364 days) ingestion exposure MRL for TCE
ATSDR has not derived a chronic (365 days or more) ingestion exposure MRL for TCE

Cancer:

Cancer calculation from exposure to TCE from reactivating the old Oak Grove Village well:

Using the assumption that TCE is carcinogenic, even though it is under review as to its carcinogenicity, the following calculation is use to approximate its theoretical risk if it would be determined to be carcinogenic in humans. It is expected that users of the Oak Grove Village

public water system will be exposed to contaminants from the old Oak Grove Village well for two years until a new well can be placed into service.

Formula:

$$\text{Cancer Risk} = \frac{\text{Exposure dose x risk factor x years of exposure}}{\text{70 years (lifetime)}}$$

Adult Cancer Risk = $\frac{0.0024 \text{ mg/Kg/day} \times 0.4 \text{ (mg/Kg/day)}^{-1} \times 2 \text{ years}}{70 \text{ years}}$ = (risk factor = 0.4 (EPA's Oral Slope Factor))

Adult Cancer Risk = 0.0000274 = 27.4 x 10^{-6} = 2.74 x 10^{-5}

Child Cancer Risk = $\frac{0.0084 \text{ mg/Kg/day} \times 0.4 \text{ (mg/Kg/day)}^{-1} \times 2 \text{ years}}{70 \text{ years}}$ =

Child Cancer Risk = 0.000096 = 96 x 10^{-6} = 9.6 x 10^{-5}