Protocol for Derivation Criteria for Water Quality Criteria for Human Consumption in Brazil

Water Quality Criteria (WQC)

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Background information

This document was produced during the workshop "Strategies to define environmental criteria for the protection of human health and the ecosystem"[3], satellite activity of the IX Congresso Brasileiro de Mutagênese, Carcinogênese e Teratogênese Ambiental, promoted by the Sociedade Brasileira de Mutagênese, Carcinogênese e Teratogênese Ambiental (SBMCTA), supported by scientific societies[4], universities[5] and governmental agencies[6] and sponsored by scientific societies[7] and companies[8].

It is a proposal of a method to establish water quality criteria for human consumption. The authors worked in one of the three working groups formed in the workshop. The other groups discussed methods to define water quality criteria for the protection of aquatic life and how to prioritize substances to be regulated.

The foreign researchers[9] presented and discussed experiences and methodologies adopted by its home institutes. Brazilian researchers[10] presented how the national criteria have been defined. After the presentations the workshop promoted a debate among the participants where national studies were discussed. It culminated on the proposal of specific derivation method for Brazil and eventually for other countries of Latin America.

In Brazil it is common to use criteria or standards defined by developed countries in North America or Europe, or those from international agencies. There is a lack regarding methods to define standards used in Brazilian laws. In most of the cases the existing criteria are copied from different organizations or countries, with differences of climate, temperature, type of water and soil, besides of the differences in technological treatment and analytical capacities and in public management policies.

Among several agencies that define their own criteria there are differences, some of them in a scale of 100 orders of magnitude[11]. Among the parameters used to define those criteria,

[3] The workshop was performed during the period of November, 16 to 20 2009, in Jundiaí, São Paulo, Brazil.
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[11] Provoost et al. Parameters causing variation between soil screening values and the effect of harmonization. J. Soils Sed. DOI 10.1007/S11368-008-0026-0 (In press)

there are variations between: the calculation algorithm, how they define the priority substances, how are quantitative risk estimated, the criteria used for their carcinogenic classification or other hazard identification, which uncertainty factors are considered, the exposure scenarios, the acceptable risk levels and others. The use of different variables and calculation may generate, consequently, different numbers with the same initial goal of protection of the human health or biota[12]. The adoption of a list of substances and criteria from different countries and their use in our legal system can lead to conflicts and inconsistency in norms. For example, a substance may be considered carcinogenic for the water regulation and not carcinogenic for soil or food regulations, depending from where the criterion was imported.

Argentina, in a pioneer effort in Latin America, defined its own list of priority substances and its own calculation algorithms for natural waters. The main uses of water were considered, taking into account the country's characteristics and needs. Even more important they have a permanent group that follows the literature and reviews constantly the adopted values. All the information is presented in a transparent way and can be assessed *on line*[13].

The derivation of criteria is a continuous process because toxicological values, the parameters used in algorithms, as well as the algorithms themselves, change with the advance of science. So, it seems clear that Brazil needs to develop its own rules for the derivation of environmental and occupational criteria. Therefore, a scientific discussion with the stakeholders of this process might be extremely important to generate rules to criteria establishment.

[12] Stouten et al. Reassessment of Occupational Exposure Limits. American Journal of IndustrialMedicine 51:407-418 (2008)

[13] Secretaria de Obras Públicas. Subsecretaria de Recursos Hídricos. ***Calidad del Agua***. Disponível em: <http://www.hidricosargentina.gov.ar/CalidadAgua.html>. Acesso em: 30/07/2008.

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1. Introduction

The objective of the proposal is to protect human health from the adverse effects of contamination of water intended for human consumption. Drinking water is any water that is intended for drinking, cooking, preparation of food and beverages or, for other domestic purposes.

Concentrations of chemical substances that can contaminate drinking water or impair its quality are to be kept as low as reasonably possible according to the generally acknowledged technical standards considering the circumstances of the individual case (the so called minimizing principle). To support this goal the present document is intended to harmonize derivation of human health based on criteria for drinking water in a consistent, transparent and scientificly based way. This document is also intended to ensure that different Brazilian state legislatures use the same methodology to establish standards; this will allow comparison among state actions.

Therefore, the suggested methodology is recommended to be applied by different regulatory agencies whenever a standard is required.

2. Criteria definition

The regulatory areas that are relevant in this context are these:

- Regulated substances (see Portaria MS 518/2004; Resolução Conama 396/2008 and others)
- Unregulated substances (priority substances list)
- Substances that are not (yet) possible or only partially possible to evaluate

The following theoretical concept is focused on two basic ideas: the availability of reliable criteria for establishing an effective risk assessment and the possibility to prioritize according to risk assessment in order to be able to distinguish between urgent and trivial problems.

2.1 Approaches for regulated substances under revision and for unregulated substances

Two approaches to the derivation of criteria are used: one for substances that are considered to have a threshold for effect and the other for substances with no threshold (most of the genotoxic carcinogens).

2.1.1 Substances with threshold dose for adverse effect

For some toxic compounds or human health effects, it is believed that there is a dose below which no adverse effect will occur. For chemicals that cause such toxic effects, a tolerable daily intake (TDI)[14] or oral reference dose (RfD) is established by different worldwide agencies.

The criterion is then derived from the TDI/RfD according to the following algorithm:

$$Cr = \frac{(TDI/RfD \times bw \times P)}{C}$$

Where:

- Cr = criterion
- bw = body weight (kg)
- P = fraction of the TDI/ RfD allocated to drinking-water
- C = daily drinking water consumption (L/day)

To set the standards, the following parameters are considered.

RfD/TDI

Until Brazil has its own values, it is suggested to use RfDs or TDIs from the following databases:

1. USEPA Integrated Risk Information System (IRIS) values first. For pesticides choose USEPA Office of Pesticide Programs (OPP).

[14]The TDI is an estimated amount of a substance in food and drinking-water, expressed on a body weight basis (mg/kg or μg/kg of body weight), that can be ingested over a lifetime without appreciable health risk.

2. If it is not available, use values from Agency for Toxic Substances and Disease Registry (ATSDR).

3. If neither 1 nor 2 are available, choose from among the following sources: the Netherlands National Institute for Public Health and the Environment (RIVM); European Union (EU); U.S. EPA Region 9, Health Effects Summary Table (HEAST); Health Canada. The data and assessments should be

- Peer reviewed
- As recent as possible
- From Good Laboratory Practices (GLP) studies
- Publicly available
- Modeled according to current state-of-art

IRIS values are extensively peer reviewed and intended for wide use. The RfDs in this database are intended for lifetime risk assessments for chemicals in all environmental media.

The EPA OPP has evaluated many pesticides registered for use in the USA. These assessments are extensively peer reviewed and are generally based on very rich and contemporary data.

ATSDR values are extensively peer reviewed. But these risk assessments were intended to be used only in evaluating human health risks around waste sites (National Priorities List - NPL sites or "superfund" sites). ATSDR publishes Minimum Risk Levels MRLs, similar to RfDs, for less than lifetime as well as for chronic human exposure. They use contemporary accepted models for quantitative assessment.

Body weight and water consumption

The values 60 Kg and 2L for adult are recommended by World Health Organization (WHO) since this parameter is already applied in Portaria MS 518/2004 or until Brazil has its own reliable parameters.

In some cases, the criterion is based on children or another life stage, wherein they are considered to be particularly vulnerable to a particular substance. In this event, a default intake of 1 liter is considered for a body weight of 10 kg. When the most vulnerable group is considered to be bottle-fed infants, an intake of 0.75 liter is considered for a body weight of 5

kg.

TDI fraction allocated for consumption

Usually, drinking water is not the only source of human exposure to the chemicals for which criteria have been derived. In many cases, the intake of chemical contaminants from drinking water is lower than from other sources, such as food, air and others. Therefore, it is necessary to consider a proportion of RfD or TDI that may be attributed to different sources in developing criterion and risk management strategies. This approach ensures that total daily intake from all sources (including drinking water containing concentrations of the chemical at or close to the criteria) does not exceed the RfD or TDI.

Wherever possible, data on the proportion of total daily intake normally ingested in drinking water (based on mean levels in food, drinking water and air) or intakes estimated on the basis of physical and chemical properties of the substances of concern are used in the derivation of criterion values. As the primary sources of exposure to chemicals are generally food (e.g., pesticide residues) and water, it is important to quantify the exposures from both sources. To inform this process, it is desirable to collect as much good quality data as possible on food intake in different parts of Brazil. The data collected can then be used to estimate the proportion of the intake that comes from food and the proportion that comes from drinking water.

Where no appropriate information on exposure from food and water is available, we apply allocation factors that reflect the likely contribution of water to total daily intake for various chemicals. In the absence of adequate exposure data, the TDI /RfD allocated from the total daily intake to drinking water is 20%, which reflects a reasonable level of exposure based on broad experience, while still being protective. In some circumstances, there is clear evidence that exposure from food is very low, for example for some of the drinking water disinfection by-products. The allocation fraction in such cases may be as high as 80%, which still allows for some exposure from other sources. In the case of some pesticides, which are likely to be found as residues in food, and from which there will be significant exposure, the allocation fraction for water may be as low as 1%.

For short-term exposures, *i.e.* emergency situations as a consequence of spills - usually to surface water, the criterion can be derived allocating 100% of the acute reference dose (ARfD) to drinking water.

2.1.2 Substances with no threshold dose for adverse effect - carcinogens and genotoxicants

In the case of compounds considered to be genotoxic carcinogens, criteria have normally been determined using a mathematical model that is linear at low dose. Criteria are conservatively presented as the concentrations in drinking water associated with an estimated upper-bound excess lifetime cancer risk of 10^{-5} (one additional cancer case per 100 000 of the population ingesting drinking water containing the substance at the criterion value for 70 years).

We recommend using cancer classifications from International Agency for Research on Cancer (IARC). Other database may be consulted: IRIS, Health Canada, and RIVM.

In this case, the criterion value for water for human consumption is determined according to the following algorithm:

$$Cr = \frac{R \times bw}{q_1 \times C}$$

Where:

- Cr = criterion
- R = drinking water risk (e.g. 10^{-5})
- bw = body weight (kg) (60 kg, as recommended for threshold values)
- q_1 = factor of carcinogenic potency (per mg/kg.day) or slope factor
- C = daily consumption of water per person (L/day)

We recommend for the factor of carcinogenic potency (risk/mg /kg.day) or slope factor, that the same order of databases be used as listed in section 2.1.1 for TDI/RfD

2.1.3 Significant figures

The criterion value should be generally rounded to one significant figure to reflect the uncertainty in animal toxicity data and/ or exposure assumptions made.

2.1.4 Provisional criteria

Criteria should be designated as Provisional Values when:

• The calculated criterion is below the practical quantification limit (QL). In this circumstance, the *criteria should be set at an achievable quantification level;*

• The calculated value is below the level that can be achieved through practical water treatment methods. In this circumstance, *criteria should be set at the practical treatment limit;*

• The calculated criterion is likely to be exceeded as result of disinfection procedures. In this circumstance, *value should be set on health basis but disinfection procedures should be granted to ensure safety from microbial pathogens.*

2.1.5 Unevaluated or partially evaluated substances

We recommend following the procedure of the Federal Environmental Agency of Germany to assess the presence of substances in drinking water in these cases:

• there are no data that would allow an assessment of human toxicology or the data are incomplete, and

• the possible presence of the chemical in drinking water is not regulated by a limit value

Under these conditions it is recommended to use a pragmatic health-based parametric value (HPV) of **0.1 ug/L**.

The HPV is a precautionary value for substances that easily disseminate in drinking water, for which an evaluation on the basis of human toxicology is not possible, or only partially possible. This recommendation is based on the so-called Threshold of Toxicological Concern (TTC) concept evaluated by several organizations for its suitability as "safe exposure criteria".

This level is calculated in such a way that a subsequent, complete evaluation of the human toxicology of a non-genotoxic substance (with an effect threshold) or of a genotoxic substances (without an effect threshold) will certainly produce an equivalent or higher criterion for lifetime consumption, which is tolerable or acceptable in terms of health.

For those substances possibly present in drinking water for which there is some information on toxicity, the following maximum (safe) values for health for lifetime consumption in drinking water can be expected:

- **≤ 0.3 ug/L**: the substance has been proven to be non-genotoxic, but otherwise there are no significant experimental toxicological data available;

- **≤ 1 ug/L**: the substance has been proven to be non-genotoxic (see above). In addition, there are significant *in vitro* and *in vivo* data on the oral neurotoxicity of the contaminant. However, these data do not produce a value lower than 0.3 ug/L;
- **≤ 3 ug/L**: the substance is neither genotoxic, nor neurotoxic (see above). In addition, there are significant *in vivo* data from at least one study on subchronic-oral toxicity of the contaminant. However, these data do not produce a value lower than 1 ug/L.

From the point of view of health, values > 3 ug/L can be tolerated for lifelong consumption in drinking water without further review, if at least one chronic oral toxicity study is available, on the grounds of which (almost) complete toxicological evaluation of the contaminant is possible and the evaluation does not produce a value lower than 3 ug/L.

3. Further recommendations and future needs

- The standards derived using this approach should be revised each six years as established in Portaria MS 518/2004 by implementing the new toxicological knowledge;
- Future development of integrative chemical analytic, toxicological and ecotoxicological concept of risk assessment;
- Consider the possibility of large water systems in Brazil monitoring of some unregulated contaminants. This would be similar to the Unregulated Contaminant Monitoring Rule in the U.S. (http://www.epa.gov/ogwdw000/ucmr/index.html);
- Drinking water source protection, applied treatment processes and monitoring program should be implemented;
- Evaluation of drinking water treatment technologies for health aspects of by-products and transformation products;
- Develop a list of water treatment substances that may be of health and ecological concern;
- Proactive participation of all social and governmental stakeholders by an open constructed dialogue;
- Seminars for education.

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ANNEX A - Example: Tebuthiuron

Environmental fate/exposure (US NLM, 2006):

Tebuthiuron is released to the environment during its use as a broad spectrum herbicide for control of herbaceous and woody plants. It may also be released to the environment during its manufacture, formulation, transport, and storage. When applied to soil, tebuthiuron persists in it for many years. Its degradation is a result of microbial activity and appears to be faster in saturated soil. Losses may occur in runoff especially when rain occurs shortly after application. Tebuthiuron is relatively immobile in soil, especially those with high organic carbon and clay content. However, in some soils, with high flow rate, it can be highly mobile. There is evidence that some tebuthiuron may chemically bind to soil over a month or two and is unavailable for biodegradation. If released in water, tebuthiuron would be expected to adsorb to sediment and possibly very slowly biodegrade. However no aquatic studies of tebuthiuron were available. Volatilization would not be expected to occur and it should not bioconcentrate in aquatic organisms. If released in the atmosphere, tebuthiuron would be removed by gravitational settling. Vapor phase of tebuthiuron would react with photochemically-produced hydroxyl radicals with a resulting half-life of 14.7 hr. Exposure to tebuthiuron is primarily occupational, especially during application. Dermal exposure may occur by coming into contact with treated soil and plants (SRC).

In Brazil, Gomes et al. (2001) analyzed well water from Fazenda São José localized in the Microbasin of Corrego Espraiado (Ribeirão Preto, SP) in the period of 1995-1999. Tebuthiuron was found in concentrations (Maximum value=0,09 ug/L) lower than the value established by EU for pesticides in drinking water. Monteiro et al. (2008) found concentrations between 0,01-0,32ug/L in water samples from Corumbataí River , in the period of 2004-2005.

Toxicological Effects (EXTOXNET, 1996):

- **Acute toxicity:** Tebuthiuron has moderate to low toxicity in experimental animals when ingested. Reported oral LD_{50} values for tebuthiuron are 644 mg/kg in rats, 579 mg/kg in mice, 286 mg/kg in rabbits, greater than 200 mg/kg in cats, and greater than 500 mg/kg in dogs. Tebuthiuron is of slight to low toxicity by skin exposure. The dermal LD_{50} for tebuthiuron in rabbits is greater than 200 mg/kg. Neither skin irritation nor general overall intoxication were produced in rabbits that had 200 mg/kg of the material

applied to their skin. Tebuthiuron did not induce sensitization or allergic reactions when tested on the skin of guinea pigs. The application of 67 mg herbicide in the eyes of rabbits produced short-term conjunctivitis, inflammation of the lining of the eye, but no irritation to other eye parts, the cornea, or the iris. The inhalation by animals of 3.7 mg/L technical tebuthiuron for 4 hours did not cause toxicity.

- **Chronic toxicity:** Decreases in body weight gain and red-blood cell counts, along with minor effects on the pancreas were seen in rats fed 125 mg/kg/day for 3 months. Exposure of rats to dietary doses of tebuthiuron as high as 80 mg/kg/day for 2 years was well tolerated, with no indication of cumulative toxicity or serious effects. Similarly, no toxic effects were observed in mice exposed to doses as high as 200 mg/kg/day for most of their lifetime, or in dogs given doses of 25 mg/kg/day for 1 year.
- **Reproductive effects:** The reproductive capacity of rats fed dietary concentrations of tebuthiuron as high as 56 mg/kg/day was unimpaired through three successive generations, and no abnormalities were detected in either parents or offspring. Tebuthiuron administered to pregnant rabbits at doses as high as 25 mg/kg/day, and to rats at doses as high as 180 mg/kg/day, produced no adverse effects on either the mothers or offspring. Based on these data, it is unlikely that tebuthiuron causes reproductive effects.
- **Teratogenic effects:** No teratogenic effects were observed when rats were fed tebuthiuron at 180 mg/kg/day. A rabbit teratology study was also negative at 25 mg/kg/day, the highest dose tested. Based on these data, it is unlikely that tebuthiuron causes birth defects.
- **Mutagenic effects:** The Ames mutagenicity assay for tebuthiuron was negative, as were assays for structural chromosome aberrations using mouse micronuclei. Based on these data, it appears that tebuthiuron is not mutagenic.
- **Carcinogenic effects:** No tumor related effects were observed in a 2-year rat feeding study at doses up to and including 80 mg/kg/day, the highest dose tested. A 2-year oncogenic study on mice was negative at 200 mg/kg/day, the highest dose tested. These data indicate that tebuthiuron is not carcinogenic.
- **Organ toxicity:** Damage to the pancreas has been observed in animal studies as a result of exposure to tebuthiuron.
- **Fate in humans and animals:** In rats, rabbits, dogs, mallards, and fish, tebuthiuron is readily absorbed into the bloodstream from the gastrointestinal tract, rapidly

metabolized, and then excreted in the urine. Tests indicate that the herbicide is broken down and excreted within 72 hours, primarily as a variety of urinary metabolites.

Derivation of water quality criteria

1- The criterion is derived from the TDI/RfD as follows:

$$Cr = \frac{(TDI/RfD \times bw \times P)}{C}$$

Where

- Cr = criterion
- bw = body weight
- P = fraction of the TDI allocated to drinking-water
- C = daily drinking-water consumption (L/day)

Tebuthiuron TDI = 0,07 mg/kg/day (USEPA, 2009)
bw = 60 kg (WHO, 2008)
P = 0.2 (20% - WHO, 2008)
C = 2L/ day (WHO, 2008)

$$Cr = \frac{0.07\ mg/kg/day \times 60\ kg \times 0.2}{2L}$$

Cr = 0,42 mg/L

2- Emergency criteria

Tebuthiuron TDI = 0,07 mg/kg/day (USEPA, 2009)
bw = 60 kg (WHO, 2008)
P = 1 (100% - WHO, 2008)
C = 2L/ day (WHO, 2008)

$$Cr = \frac{0,07\ mg/kg/day \times 60\ kg \times 1}{2\ L/day}$$

Cr = 2,1 mg/L

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ANNEX B – Example: Benzene

CASRN: 71-43-2

Environmental fate /exposure (US NLM, 2006):

Benzene is an aromatic hydrocarbon used as a solvent. It is primarily produced from petroleum products. The presence of benzene in gasoline and its use in the production of ethylbenzene and styrene as well as many other chemicals may result in its release to the environment. If released to air, a vapor pressure of 94.8 mm Hg at 25 degrees Celsius indicates benzene will exist solely as a vapor in the ambient atmosphere. Vapor phase benzene will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 13 days. Vapor-phase benzene is also degraded by ozone radicals and nitrate found in the atmosphere but at such low rates as to not be important. Since benzene is very water soluble, it may be removed from the atmosphere by rain. If released to soil, benzene is expected to have high mobility based upon a Koc of 85. Volatilization from moist soil surfaces is expected to be an important fate process; it may also occur in dry soils. Concentrations of 20 ppm of benzene are expected to be 24% degraded in 1 week, 44% in 5 weeks, and 47% in 10 weeks. If released into superficial water, benzene volatilizes in 1 hour in rivers and 3.5 days in lakes. Benzene remains in water column, it is not expected to adsorb to sediment and suspended solids. In this environment, the biodegradation occurs by aerobic bacterial after 12 hrs of incubation, with 50% of benzene degrading after 60 hrs. In aqueous solution, benzene will react with hydroxyl radical presenting an estimated half-life of 103 days. The aquatic bioconcentration factors range from 1 to 20 suggesting a low bioconcentration of the compound in aquatic organisms. Environmental exposure is greatest in areas of heavy automobile use due to the presence of benzene in tailpipe emissions, near service stations and from tobacco smoke.

In 2004, Brito et al (2005) analyzed in more than 3000 groundwater samples collected around gas station sites in Brazil particularly south and southeast regions. 30% of those samples were above Brazilian and international intervention criteria for benzene.

Toxicological Effects:

- **Acute Toxicity:** Benzene is moderately irritating to mucosas, and its aspiration in high concentrations may cause pulmonary edema. The vapors are, also irritating for ocular and respiratory mucosas. Exposure to high concentrations of benzene results in toxic effects to he central nervous system causing, depending on the amount absorbed,

excitation followed by somnolence, dizziness, headache, nausea, tachycardia, respiratory difficulty, tremors, convulsions, narcosis, loss of consciousness and death.

- **Chronic Toxicity** (Pedrozo et al, 2002)**:** Chronic exposure to benzene results in hematologic alterations, including aplastic anemia, pancytopenia, or any combination of anemia, leucopenia, and thrombocytopenia. Leukemia and chromosomal aberrations have been observed in exposed populations. Neuropsychological and neurologic alterations have also been reported following chronic exposure: in attention, memory, motor ability, visiospacial, visioconstructive, executive function, logic reasoning, language, learning and behavior.
- **Reproductive toxicity, embryotoxicity and teratogenicity:** Benzene crosses the placental barrier freely. There are no data showing that it is teratogenic even at maternally toxic doses. However, it has been shown to be fetotoxic following inhalation exposure in mice (1600 $\mu g/m^3$, 7 h/day, gestation days 6-15) and in rabbits.
- **Genotoxicity and carcinogenicity:** Benzene has given negative results in mutagenicity assays i*n vitro.* In *in vivo* studies, benzene or its metabolites cause both structural and numerical chromosome aberrations in humans and laboratory animals. Abnormalities in sperm were also observed. Benzene has been reported to cause the production of several types of neoplasms in both rats and mice after either oral dosing or inhalation exposures; these include leukemias, lymphomas, nasal cavity neoplasias, liver and mammary tissue epithelial neoplasias. Benzene is recognized as a carcinogen for humans based on evidences obtained from epidemiologic studies – the cancer most often observed is myeloid leukemia.
- **Pharmacokinetics in humans:** Due to its liposolubility, benzene is stored preferentially in the adipose tissue. Ten to 50% of absorbed benzene is eliminated in its unchanged form through the exhaled air and about 0.1% is excreted unchanged in urine (depending on the dose, metabolic activity and quantity of lipids in the organism). The first step on benzene's biotransformation process occurs with the formation of benzene epoxide, by mixed function oxidases, mediated by cytochrome P-450. There are two metabolic routes: aromatic ring hydroxylation forming phenol, catechol and hydroquinone (from 15 to 20%); or ring opening forming trans,trans-muconic acid (AttM) (about 2%), which are excreted in urine as conjugates.

Derivation of criteria

The criterion is derived as follows:

$$Cr = \frac{R \times bw}{q_1 \times C}$$

Where:

Cr = criterion

R = drinking water risk = 1×10^{-5}

bw = body weight (kg) = 60 Kg

q_1 = factor of carcinogenic potency (per µg/kg/day) or slope factor = 5.5×10^{-2} (per mg/kg/day) (IRIS)

C = daily consumption of water per person (L/day) = 2 L/day

$$Cr = \frac{10^{-5} \times 60\ kg \times 10^{3}\ \mu g/mg}{5.5 \times 10^{-2}\ /\ mg\ /\ kg\ /day \times 2L\ /day}$$

Cr = 5,45 ug /L rounded to 5 ug/L

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ANNEX C – NJDEP (New Jersey Department of Environmental Protection) risk assessment methodology for Group C carcinogens

Group C carcinogens are those agents categorized as possible human carcinogens because the evidence for carcinogenicity is not sufficient for them to be categorized as probable human carcinogens (Group B2). To develop health-based levels (standards/criteria) for Group C carcinogens with a consistent approach throughout its implementing programs, the Department has established with USEPA's various programs. The Department's new approach specifies that health-based levels for Group C carcinogens be developed through the use of cancer slope factor at 10^{-6} excess cancer risk over a lifetime of exposure, if such slope factor is available and judged by the Department to be technically sound and based on adequate toxicological data. If such a slope factor is not available, the risk assessment will be based on non-carcinogenic effects using the Reference Dose (RfD) with an additional uncertainty factor of 10 to protect from possible carcinogenic effects.

For constituents classified as non-carcinogens for which no carcinogenic slope factor is applicable, the criterion shall be derived using the following equation:

$$\text{Criterion } (\mu g/L) = \frac{\text{Reference Dose} \times \text{Average Adult Weight} \times \text{Conversion Factor} \times \text{Relative Source Contribution}}{\text{Assumed Daily Water Consumption} \times \text{Uncertainty Factor}}$$

Where the default values are:

Average Adult Weight	= 70 kg
Relative Source Contribution	= 20 Percent
Assumed Daily Water Consumption	= 2 liters per day
Conversion Factor	= 1,000 µg/mg
Reference Dose	= value from the USEPA IRIS data base, http://www.epa.gov/iris/, as (mg/kg-day)
Uncertainty Factor	= 10 for carcinogens for which no carcinogenic slope factor is applicable; 1 for non-carcinogens