National Institute
for Public Health
and the Environment

Letter report 601782008/2008
C.W.M. Bodar

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This investigation has been performed by order and for the account of the Directorate-General for Environmental Protection, Directorate for Chemicals, Waste and Radiation (SAS), within the framework of 'International and National Environmental Quality Standards for Substances in the Netherlands' (INS).

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Acknowledgements

The results of the present report have been discussed in the scientific advisory group INS (WK INS). The members of this group are acknowledged for their contribution. Paul Janssen and Gerlienke Schuur (both RIVM-SIR) are thanked for their assistance in the human toxicological part.

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Rapport in het kort

Environmental risk limits for 2-(2-butoxyethoxy)ethanol (DEGBE)

Dit rapport geeft milieurisicogrenzen voor 2-(2-butoxyethoxy)ethanol (DEGBE) in (grond)water en bodem. Milieurisicogrenzen zijn de technisch-wetenschappelijke advieswaarden voor de uiteindelijke milieukwaliteitsnormen in Nederland. De milieurisicogrenzen voor DEGBE zijn gebaseerd op de uitkomsten van de EU risicobeoordeling voor DEGBE (Bestaande Stoffen Verordening 793/93). De afleiding van de milieurisicogrenzen sluit tevens aan bij de richtlijnen uit de Kaderrichtlijn Water.

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Summary

Environmental risk limits (ERLs) are derived using ecotoxicological, physico-chemical, and human toxicological data. They represent environmental concentrations of a substance offering different levels of protection to man and ecosystems. It should be noted that the ERLs are scientifically derived values. They serve as advisory values for the Dutch Steering Committee for Substances, which is appointed to set the Environmental Quality Standards (EQSs) from these ERLs. ERLs should thus be considered as preliminary values that do not have any official status.

This report contains ERLs for 2-(2-butoxyethoxy)ethanol (DEGBE) in water, groundwater and soil. The following ERLs are derived: negligible concentration (NC), maximum permissible concentration (MPC), maximum acceptable concentration for ecosystems (MAC_{eco}), and serious risk concentration for ecosystems (SRC_{eco}). The risk limits were solely based on data presented in the Risk Assessment Reports (RAR) for this compound, created under the European Existing Substances Regulation (793/93/EEC). No risk limits were derived for the sediment compartment, because of the relatively low sediment-water partition coefficient. For DEGBE, also no risk limits for the air compartment were derived (not relevant).

For the derivation of the MPC and MAC_{eco} for water, the methodology used is in accordance with the Water Framework Directive. This methodology is based on the Technical Guidance Document on risk assessment for new and existing substances and biocides (European Commission (Joint Research Centre), 2003). For the NC and the SRC_{eco} and for the ERLs for the soil and atmospheric compartment, the guidance developed for the project 'International and National Environmental Quality Standards for Substances in the Netherlands' was used (Van Vlaardingen and Verbruggen, 2007). An overview of the derived environmental risk limits is given in Table 1.

Table 1. Derived MPC, NC, MAC_{eco}, and SRC_{eco} values for DEGBE.

ERL	unit	value			
		MPC	NC	MAC_{eco}	SRC_{eco}
$MPC_{eco, water}$	*$mg.l^{-1}$*	*1.0*			
$MPC_{dw, water}$	*$mg.l^{-1}$*	*17.5*			
$MPC_{sp, water}$	*$mg.l^{-1}$*	*n.d.*			
$MPC_{hh food, water}$	*$mg.l^{-1}$*	*n.d.*			
water [a]	$mg.l^{-1}$	1.0	0.01	115	196
drinking water [a]	$mg.l^{-1}$	17.5			
marine, eco	$mg.l^{-1}$	0.1		11.5 [b]	
sediment		n.d.			
soil [c]	$mg.kg_{dw}^{-1}$	0.6	0.006		118
groundwater	$mg.l^{-1}$	1.0	0.01		

n.d. = not determined

[a] the $MPC_{dw, water}$ is always noted as a separate value from the other MPC_{water} values ($MPC_{eco, water}$., $MPC_{sp, water}$ or $MPC_{hh, food, water}$). From these other MPC's$_{water}$ (thus excluding the $MPC_{dw, water}$) the lowest one is taken forward as the 'overall' MPC_{water}. Subsequently, the NC_{water} is always based on this overall MPC_{water} value (1/100th). This irrespective if this value is lower than the $MPC_{dw, water}$ or not.

[b] provisional value

[c] expressed on Dutch standard soil

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1 Introduction

1.1 Project framework

In this report environmental risk limits (ERLs) for surface water (freshwater and marine), soil and groundwater are derived for 2-(2-butoxyethoxy)ethanol (DEGBE). The following ERLs are considered:

- negligible concentration (NC) – concentration at which effects to ecosystems are expected to be negligible and functional properties of ecosystems must be safeguarded fully. It defines a safety margin which should exclude combination toxicity. The NC is derived by dividing the MPC (see next bullet) by a factor of 100.
- maximum permissible concentration (MPC) – concentration in an environmental compartment at which:
  1 no effect to be rated as negative is to be expected for ecosystems;
  2a no effect to be rated as negative is to be expected for humans (for non-carcinogenic substances);
  2b for humans no more than a probability of 10^{-6} over the whole life (one additional cancer incident in 10^6 persons taking up the substance concerned for 70 years) can be calculated (for carcinogenic substances) (Lepper, 2005).
- maximum acceptable concentration (MAC_{eco}) – concentration protecting aquatic ecosystems for effects due to short-term exposure or concentration peaks.
- serious risk concentration (SRC_{eco}) – concentration at which serious negative effects in an ecosystem may occur.

It should be noted that ERLs are scientifically (based on (eco)toxicological, fate and physico-chemical data) derived values. They serve as advisory values for the Dutch Steering Committee for Substances, which is appointed to set the Environmental Quality Standards (EQSs) from these ERLs. ERLs should thus be considered as preliminary values that do not have any official status.

2 Methods

2.1 Data collection

The final Risk Assessment Report (RAR) of DEGBE produced in the framework of Existing Substances Regulation (793/93/EEC) was used as only source of physico-chemical and (eco)toxicity data (European Commission, 2000). Information given in the RARs is checked thoroughly by European Union member states (Technical Committee) and afterwards approved by the Scientific Commission on Health and Environmental Risk (SCHER). Therefore, no additional evaluation of data is performed for the ERL derivation. Only valid data combined in an aggregated data table are presented in the current report. Occasionally, key studies are discussed when relevant for the derivation of a certain ERL.

In the aggregated data table only one effect value per species is presented. When for a species several effect data are available, the geometric mean of multiple values for the same endpoint is calculated where possible. Subsequently, when several endpoints are available for one species, the lowest of these endpoints (per species) is reported in the aggregated data table.

2.2 Methodology for derivation of environmental risk limits

The methodology for data selection and ERL derivation is described in Van Vlaardingen and Verbruggen (2007) which is in accordance with Lepper (2005). For the derivation of ERLs for air, no specific guidance is available. However, as much as possible the basic principles underpinning the ERL derivation for the other compartments are followed for the atmospheric ERL derivation (if relevant for a chemical).

3 Derivation of environmental risk limits for 2-(2-butoxyethoxy)ethanol

3.1 Substance identification, physico-chemical properties, fate and human toxicology

3.1.1 Identity

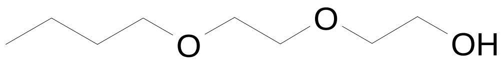

Figure 1. Structural formula of DEGBE.

Table 2. Identification of DEGBE.

Parameter	Name or number
Chemical name	2-(2-butoxyethoxy)ethanol
Common/trivial/other name	DEGBE, butoxyethoxyethanol, butyl carbitol, butyl diglycol, butyl diglycol ether, butyl digol, butyl dioxitol, diethylene glycol butyl ether, diglycol monobutyl ether, Dowanol DB
CAS number	112-34-5
EC number	203-961-6
Molecular formula:	$C_8H_{18}O_3$

3.1.2 Physico-chemical properties

Table 3. Physico-chemical properties of DEGBE.

Parameter	Unit	Value	Remark
Molecular weight	[g.mol^{-1}]	162.2	
Water solubility	[g.l^{-1}]	miscible	
log K_{OW}	[-]	0.56	
K_{OC}	[l/kg]	3.6	Value from RAR based on default QSAR TGD 1996/EUSES 1.0. Slightly higher K_{oc} value would be estimated when using TGD 2003/EUSES 2.0.
Vapour pressure	[hPa]	0.027	at 20ºC
Melting point	[°C]	-68	
Boiling point	[°C]	228-234	
Henry's law constant	[Pa.m^3.mol^{-1}]	4.4x10^{-3}	at 20ºC

3.1.3 Behaviour in the environment

Table 4. Selected environmental properties of DEGBE.

Parameter	Unit	Value	Remark
hydrolysis half-life	DT_{50} [d]	-	Experimental data were not reported. However, DEGBE is not expected to hydrolyse based on the absence of hydrolysable groups (RAR information).
photolysis half-life	DT_{50} [h]	-	*RAR: "Since DEGBE does not adsorb ultraviolet radiation within the solar spectrum, direct photolysis in the atmosphere is not expected to occur"*. A half life of 11 hours is estimated for photo-oxidation (reaction with OH radicals). No specific data on photolysis in water.
degradability	readily biodegradable		

The RAR gives some general considerations on the environmental distribution of DEGBE: *" It is concluded that DEGBE is readily degradable. The Henry's Law constant of 4.4 * 10^{-3} Pa.m^{-3}/mol at 20°C (EUSES) indicates that volatilization of DEGBE from surface waters and moist soil is expected to be very low. Using the log K_{ow} of 0.56, according to the TGD a K_{oc} of 3.6 l/kg can be estimated. Based on this K_{oc} DEGBE is expected to be highly mobile in soil. It should be borne in mind, however that the derivation of a K_p from low log K_{ow} values is less reliable. Whilst physical removal from the atmosphere by precipitation and dissolution in clouds can occur, the short atmospheric residence time (reaction with OH radicals; DT_{50} of 11 hours) suggests that wet deposition is of limited importance."*

3.1.4 Bioaccumulation and biomagnification

Table 5. Overview of bioaccumulation data for DEGBE.

Parameter	Unit	Value	Remark
BCF (fish)	[$l.kg^{-1}$]	1.4	Calculated based on K_{ow}
BCF (mussel)	[$l.kg^{-1}$]	n.a.	
BMF	[$kg.kg^{-1}$]	1	

No experimental data on bioaccumulation is available. Therefore BCF-value for fish was calculated in the RAR using the log K_{ow}. The estimated BCF-value amounts to 1.4 (l/kg) for fish.. Although it is realised that the relationship between BCF and log K_{ow} may not be valid at such low log K_{ow}-values it can be concluded that in view of this BCF, DEGBE is expected to have a low bioaccumulating potential in the environment.

3.1.5 Human toxicological threshold limits and carcinogenicity

Classification and labelling according to the 25th ATP of Directive 67/548/EEC:
Classification: Xi; R36
Labelling: Xi R36 S(2-)24-26

No TDI (or equivalent) or TCA (or equivalent) is available for DEGBE.
There are no carcinogenicity studies with animals nor human data available. The lack of mutagenic potential and the effects observed in the repeated dose toxicity studies do not give cause for concern for carcinogenicity (RAR information).
The RAR gives a lowest oral NOAEL of 500 mg/kg bw/day for DEGBE from an oral developmental study in rats. An inhalatory NOAEL of 17 mg/m^3 is reported from a 90-day rat study.

3.2 Trigger values

This section reports on the trigger values for MPC_{water} derivation (following WFD methodology).

Table 6. DEGBE: collected properties for comparison to MPC triggers for water ERL-derivation. N.a. = not available.

Parameter	Value	Unit	Method/Source
log $K_{P,susp-water}$	- 0.44	[-]	$K_{OC} \times f_{OC,susp}$[1]
BCF	1.4	[$l.kg^{-1}$]	
BMF	1	[-]	
log K_{OW}	0.56	[-]	
R-phrases	R36	[-]	
A1 value	n.a.	[$\mu g.l^{-1}$]	
DW standard	n.a.	[$\mu g.l^{-1}$]	

[1] $f_{OC,susp} = 0.1\ kg_{OC}.kg_{solid}^{-1}$ ((European Commission (Joint Research Centre), 2003)).
K_{OC} = 3.6 l/kg.

- DEGBE has a log $K_{P,\ susp\text{-}water}$ << 3; derivation of $MPC_{sediment}$ is not triggered.
- DEGBE has a log $K_{P,\ susp\text{-}water}$ << 3; expression of the MPC_{water} as $MPC_{susp,\ water}$ is not required.
- DEGBE is not suspected to bioaccumulate on basis of its low K_{ow}; assessment of secondary poisoning is not triggered.
- DEGBE has an R36 classification. Therefore, MPC_{water} for human health via food (fish) consumption ($MPC_{hh\ food,\ water}$) does not need to be derived.

3.3 Toxicity data and derivation of ERLs for water

3.3.1 $MPC_{eco,\ water}$ and $MPC_{eco,\ marine}$

Acute toxicity data for DEGBE as reported in the RAR are listed in Table 7.

Table 7. DEGBE: selected acute data for ERL derivation.

Taxonomic group	$L(E)C_{50}$ ($mg.l^{-1}$)
Algae	
Scenedesmus subspicatus	>100
Crustacea	
Daphnia magna	2850
Daphnia magna	>100
Daphnia magna	3200
Daphnia magna	3184
Pisces	
Carassius auratus	2700
Lepomis macrochirus	1300
Poecilia reticulata	1150
Leuciscus idus melanotus	2750
Leuciscus idus melanotus	1805
Leuciscus idus melanotus	2305

There is one marine study presented in the RAR for DEGBE: a short-term fish test with *Menidia beryllina* with a LC_{50} value of 2000 mg/l.
In addition to the acute toxicity data, chronic toxicity data were available for DEGBE (Table 8).

Table 8. DEGBE: selected chronic data for ERL derivation.

Taxonomic group	NOEC ($mg.l^{-1}$)
Bacteria	
Pseudomonas putida	1170
Pseudomonas putida	255
Protozoa	
Chilomonas paramecium	2774
Entosiphon sulcatum	73
Uronema parduczi	420
Algae	
Scenedesmus quadricauda	1000
Microcystis aeruginosa	53

Treatment of fresh- and saltwater toxicity data

No marine PNEC was derived in the RAR. In the current report freshwater and marine data were pooled for the MPC_{eco} derivations (similar sensitivity).

Derivation of $MPC_{eco, water}$ and $MPC_{eco, marine}$

In the RAR the PNEC for the aquatic compartment is extrapolated from the NOEC of 53 mg/l for *Microcystis aeruginosa* using an extrapolation factor of 50. *"This factor is chosen because chronic data are available for two trophic levels (algae and micro-organisms) and, additionally, these NOECs seem to cover the most sensitive taxonomic groups (relatively low NOEC values). Both taxonomic groups are also represented by a number of species.*
Short-term QSAR-values (according to TGD96) for fish and daphnids of, respectively, 2200 and 2300 mg/l, are consistent with the experimental data for both taxonomic groups. However, the experimental NOEC for M. aeruginosa is rather low compared with the short-term QSAR-value for algae of 2600 mg/l (a ratio acute:chronic of 10 would give a NOEC of 260 mg/l). It would be difficult to explain this low value of M. aeruginosa on biological/structural grounds and assumed mode of action (narcotic). The extrapolation leads to a PNEC for the aquatic environment of 1 mg/l."
The $MPC_{water, eco}$ is equal to the $PNEC_{aquatic}$. Thus = 1 $mg.l^{-1}$.
It should be noted that in the RAR on DEGBE micro-organisms were taken into account when deriving a PNEC for water. In most RARs data on aquatic micro-organisms only serve as input for a PNEC for sewage treatment plants.

In the RAR no effect assessment for the marine environment is carried out. When following the TGD and using the pooled dataset for freshwater and marine organisms an assessment factor of 500 should be applied to the lowest NOEC of 53 mg/l. -> $MPC_{marine, eco}$ = 0.1 $mg.l^{-1}$.

3.3.2 $MPC_{sp, water}$ and $MPC_{sp, marine}$

DEGBE has a BCF<100. Thus, assessment of secondary poisoning is not triggered (Table 6).

3.3.3 $MPC_{hh\ food,\ water}$

Derivation of $MPC_{hh\ food,\ water}$ for DEGBE is not triggered (Table 6).

3.3.4 $MPC_{dw,\ water}$

No A1 value and DW standard are available for DEGBE. In the RAR for DEGBE, an oral NOAEL of 500 mg/kg bw/day is used. The TL_{hh} = 500/100 = 5 mg/kg bw/day. The $MPC_{dw,\ water,\ provisional}$ = $(0.1*TL_{hh} * BW)$/uptake = (0.1 * 5 * 70)/2 = 17.5 $mg.l^{-1}$. According to the model of Zwolsman et al. (2004) the fraction not removable by simple surface water treatment amounts to 0.999 for DEGBE. The $MPC_{dw,\ water,}$ is therefore 17.5 $mg.l^{-1}$.

3.3.5 Selection of the MPC_{water} and MPC_{marine}

In the Fraunhofer document (Lepper, 2005) it is prescribed that the lowest MPC value should be selected as the general MPC. In the proposal for the daughter directive Priority Substances, a standard based on drinking water was not included. Provisionally, in the Netherlands the $MPC_{dw,\ water}$ will always be noted as a separate value from the other MPC_{water} values ($MPC_{eco,\ water}$., $MPC_{sp,\ water}$ or $MPC_{hh,\ food,\ water}$). From these other MPC's$_{water}$ (thus excluding the $MPC_{dw,\ water}$) the lowest one is taken forward as the 'overall' MPC_{water}. Subsequently, the NC_{water} is always based on this overall MPC_{water} value ($1/100^{th}$). This irrespective if this value is lower than the $MPC_{dw,\ water}$ or not.
The $MPC_{dw,\ water}$ = 17.5 $mg.l^{-1}$.
The MPC_{water} is the $MPC_{water,\ eco}$ (lowest value of the other values) of 1 $mg.l^{-1}$.
The only marine MPC of 0.1 $mg.l^{-1}$ is set as MPC_{marine}. MPC_{marine} = 0.1 $mg.l^{-1}$.

3.3.6 $MAC_{eco,\ water}$

The EC_{50}-value of 1150 $mg.l^{-1}$ for *Poecilia reticulata* is the lowest reported acute toxicity value in the RAR. The base set is complete and DEGBE has no potential to bioaccumulate. Furthermore the acute toxicity data for different species do not seem to differ more than a factor two or three. Therefore, an assessment factor of 10 is applied. The MAC_{eco} for fresh water is 1150 $mg.l^{-1}$/10 = 115 $mg.l^{-1}$.

$MAC_{eco,\ marine}$ amounts to 115/10 = 11.5 $mg.l^{-1}$. It has to be noted that this procedure for $MAC_{eco,\ marine}$ is currently not agreed upon. Therefore, the $MAC_{eco,marine}$ value needs to be re-evaluated once an agreed procedure is available.

3.3.7 NC_{water}

The NC_{water} is set to a factor of 100 below the MPC_{water}. NC_{water} is 1/100 = 0.01 mg/l.

3.3.8 $SRC_{eco,\ water}$

For the calculation of the geometric mean of acute freshwater toxicity data, the data from Table 7 were used. Unbounded values (>) were not used in this calculation. This results in a value of 1960 mg/l. It is realised that algae data are not directly considered in this derivation. Comparing this value divided by 10 (= 196 mg/l) with the geometric mean of available NOEC values from Table 8 (370 mg/l) shows that the $SRC_{eco,\ water}$ should be based on the acute data (see Table 27 of Van Vlaardingen and Verbruggen, 2007). The $SRC_{eco,\ water}$ for DEGBE therefore amounts to 196 $mg.l^{-1}$.

3.4 Toxicity data and derivation of ERLs for sediment

The log $K_{p,\ susp\text{-}water}$ of DEGBE is below the trigger value of 3, therefore, ERLs are not derived for sediment.

3.4.1 Toxicity data and derivation of ERLs for soil

No experimental data on toxicity to soil organisms are reported in the RAR.

3.4.1.1 MPC$_{soil,\ sp}$

The MPC$_{soil,\ sp}$ is not triggered for DEGBE (no potential to bioaccumulate).

3.4.1.2 MPC$_{eco,\ soil}$

In the RAR, the equilibrium partitioning method is applied according to the TGD. EUSES is reported to have generated a PNEC$_{terrestrial}$ of 0.2 mg.kg$_{dwt}^{-1}$. After conversion to Dutch standard soil the value for the MPC$_{eco,\ soil}$ becomes 0.2*5.88/2 = 0.6 mg.kg$_{dwt}^{-1}$. It should be noted that the use of the equilibrium partitioning method is questionable for chemicals with a low hydrophobicity (log K_{ow} of 0.56).

3.4.1.3 MPC$_{human,\ soil}$

The MPC$_{human,\ soil}$ is based on the NOAEL of 500 mg/kg bw/day (see paragraph 3.2). The TL_{hh} = 500/100 = 5 mg/kg bw/day. Specific human intake routes are allowed to contribute 10% of the human toxicological threshold limit. Four different routes contributing to human exposure have been incorporated: consumption of leaf crops, root crops, milk and meat. The critical route for DEGBE was calculated to be consumption of leaf crops. The MPC$_{soil,\ human}$ was determined to be 10.6 mg.kg$_{dwt}^{-1}$ Dutch standard soil.

3.4.1.4 Selection of the MPC$_{soil}$

The lowest MPC$_{soil}$ is the MPC $_{eco,\ soil}$ of 0.6 mg.kg$_{dwt}^{-1}$ Dutch standard soil.

3.4.1.5 NC$_{soil}$

The NC$_{soil}$ is set a factor 100 lower than the MPC$_{soil}$. NC$_{soil}$ = 6 µg.kg $_{dwt}^{-1}$ Dutch standard soil.

3.4.1.6 SRC$_{eco,\ soil}$

No terrestrial data are presented in the RAR for DEGBE. The SRC-value can be based on equilibrium partitioning but it is again emphasized that the validity of the partitioning coefficients is questionable (low K_{ow}). From the SRC$_{eco,\ water}$ of 196 mg/l an SRC$_{eco,\ soil}$ of 40*5.88/2 = 118 mg.kg$_{dwt}^{-1}$ is derived for Dutch standard soil.

3.4.2 Derivation of ERLs for groundwater

3.4.2.1 $MPC_{eco, gw}$

Since groundwater-specific ecotoxicological information is absent, the derived ERLs for surface water based on ecotoxicological data are taken as substitute. Thus, $MPC_{eco, gw} = MPC_{eco, water} = 1\ mg.l^{-1}$.

3.4.2.2 $MPC_{human, gw}$

The $MPC_{human, gw}$ is set equal to the $MPC_{dw, water}$. Thus, $MPC_{human, gw} = MPC_{dw, water} = 17.5\ mg.l^{-1}$.

3.4.2.3 Selection of MPC_{gw}

The lowest available MPC is the $MPC_{eco, gw}$ of 1 $mg.l^{-1}$. Thus, the final $MPC_{gw} = 1\ mg.l^{-1}$.

3.4.2.4 NC_{gw}

The NC_{gw} is set a factor 100 lower than the MPC_{gw}. Thus, $NC_{gw} = 1/100 = 0.01\ mg.l^{-1}$.

3.4.3 Derivation of ERLs for air

In the RAR for DEGBE no ecotoxicological data are available for the atmospheric compartment. Therefore, no $MPC_{eco, air}$ can be derived.

In the RAR, risk for humans exposed via the atmosphere is estimated on basis of a inhalatory NOAEL of 17 mg/m^3. However, because of the low Henry's Law constant and its short residence time in air, no MPC_{air} was derived for DEGBE (not relevant).

4 Conclusions

In this report, the environmental risk limits negligible concentration (NC), maximum permissible concentration (MPC), maximum acceptable concentration for aquatic ecosystems (MAC_{eco}), and serious risk concentration for ecosystems (SRC_{eco}) are derived for DEGBE in water, groundwater and soil. No risk limits were derived for the sediment compartment because exposure of sediment is considered negligible. Also no ERLs for air were derived for DEGBE. The ERLs that were obtained are summarised in Table 9 below.

Table 9. Derived MPC, NC, MAC_{eco}, and SRC_{eco} values for DEGBE.

ERL	unit	value			
		MPC	NC	MAC_{eco}	SRC_{eco}
$MPC_{eco, water}$	*$mg.l^{-1}$*	*1.0*			
$MPC_{dw, water}$	*$mg.l^{-1}$*	*17.5*			
$MPC_{sp, water}$	*$mg.l^{-1}$*	*n.d.*			
$MPC_{hh food, water}$	*$mg.l^{-1}$*	*n.d.*			
water [a]	$mg.l^{-1}$	1.0	0.01	115	196
drinking water [a]	$mg.l^{-1}$	17.5			
marine, eco	$mg.l^{-1}$	0.1		11.5 [b]	
sediment		n.d.			
soil [c]	$mg.kg_{dw}^{-1}$	0.6	0.006		118
groundwater	$mg.l^{-1}$	1.0	0.01		

n.d. = not determined

[a] the $MPC_{dw, water}$ is always noted as a separate value from the other MPC_{water} values ($MPC_{eco, water}$., $MPC_{sp, water}$ or $MPC_{hh, food, water}$). From these other MPC's$_{water}$ (thus excluding the $MPC_{dw, water}$) the lowest one is taken forward as the 'overall' MPC_{water}. Subsequently, the NC_{water} is always based on this overall MPC_{water} value (1/100th). This irrespective if this value is lower than the $MPC_{dw, water}$ or not.

[b] provisional value

[c] expressed on Dutch standard soil

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