

The Minister of of Housing,  
Spatial Planning and the Environment  
PO Box 30945  
2500 GX The Hague

TCB A040(2008)

31 January 2008

Re: Advisory Report ETBE Standards

Dear Minister,

In response to your request for advice<sup>1</sup>, the Soil Protection Technical Committee (TCB) is pleased to present its conclusions regarding the introduction of a remediation standard for the substance ethyl-*tert*-butylether (ETBE) in groundwater. This substance is closely related to the substance methyl-*tert*-butylether (MTBE) about which the TCB recently sent you an advisory report regarding a remediation standard in groundwater<sup>2</sup>. Both substances are used in petrol to increase the octane content (as an anti-knock agent).

#### THE REQUEST FOR ADVICE

The request for advice asked the committee's opinion about using the same remediation standard for ETBE as for MTBE, that is, a uniform remediation standard of 15 µg/l (the odour threshold for MTBE in drinking water).

#### THE PROBLEM

Whether there is (significant) ETBE pollution in groundwater has not yet been properly investigated. The reason for laying down standards for ETBE in groundwater is the expected large-scale use of ETBE, as biofuel, in petrol in the future<sup>3</sup>. Given the similarity in properties and applications of ETBE with those of MTBE, there is a potential risk of pollution of the groundwater. After all, MTBE contamination of groundwater has been ascertained at petrol filling stations<sup>4</sup> and drinking water abstraction points<sup>5</sup>

---

<sup>1</sup> Request for advice on establishing ETBE standards, reference BWL/2007105842, 5 November 2007.

<sup>2</sup> Advisory Report MTBE standards, reference TCB S45(2007), 19 July 2007.

<sup>3</sup> Approximately half of ETBE can be deemed as biofuel if produced from the raw ingredients bio-ethanol and isobutylene.

<sup>4</sup> Tauw, *Landelijk inventariserend onderzoek MTBE-verontreiniging in Nederland; onderzoek en interpretatie MTBE-data tankstations en depots*. Tauw BV, 29 March 2007, on the instructions of the Ministry of Housing, Spatial Planning and the Environment.

Both substances are mobile in groundwater, are slow to biodegrade and have a low odour and taste threshold. The TCB advised that a single uniform remediation standard of 15 µg/l be laid down for MTBE in groundwater. This concentration is based on the odour threshold of MTBE in groundwater, because the odour nuisance is the most critical effect.

In the case of ETBE contamination, either the Environmental Management Act (licence) or Article 13 of the Soil Protection Act (duty of care) is applicable. If the contamination was caused by an establishment subject to the Environmental Management Act, and, moreover, a baseline investigation is available, the result of this baseline investigation applies as remediation objective. The expectation is, however, that there will be no baseline investigation available for ETBE and that if a baseline investigation is available, no ETBE would have been present in the groundwater at the time of the investigation. In this case, Article 13 of the Soil Protection Act is applicable.

In the latter case, in principle, the remediation objective is that the person or entity responsible for causing the contamination (the perpetrator) remediates it as far as possible. This can be formalised by laying down a remediation standard. Article 13 also contains a criterion of reasonableness. According to this criterion, the remediation objective depends on the specific situation. This applies if the perpetrator can show the competent authority why the remediation objective cannot reasonably be realised and reasons why a specific individual remediation standard can be realised.

No standards or risk limits are available for ETBE in soil and groundwater. At your request, this advisory report considers the remediation standard to be applied in the case of clean-up measures taken under the duty of care (Article 13 of the Soil Protection Act).

## PROPERTIES, PRODUCTION AND USE OF, AND CONTAMINATION WITH, ETBE

ETBE is highly-soluble volatile substance, as is MTBE. The substance is slow to biodegrade in the soil and groundwater<sup>6</sup>. Under laboratory conditions degradation is possible both under aerobic and anaerobic conditions<sup>7</sup>. A description of the degradation kinetics under field conditions is not yet available<sup>8</sup>. Neither is there currently any insight into the lower limit of biodegradation in the field, that is, the lowest concentration of the substance at which degradation by micro-organisms still takes place.

ETBE is chemically produced from ethanol (47%) and isobutylene (53%). If the ethanol used is produced from energy crops (bio-ethanol), the ETBE can be deemed 47% biofuel (bio-ETBE). The expectation is that the level of bio-ETBE in petrol in the Netherlands will increase significantly. The appeal of bio-ETBE (in preference to MTBE) is largely determined by a fiscal advantage permitted by Europe and intended to promote biofuels. In addition, by using bio-ETBE it is easier for the Netherlands to meet the European Directive for biofuels, which stipulates that the biofuel content in petrol and diesel must increase from 2% (in 2005) to 5.75% in 2010. The additive MTBE can be replaced by ETBE without (technical) objections.

---

<sup>5</sup> *De kwaliteit van het drinkwater in Nederland*, reports for 2005 and 2006. Inspectorate for Housing, Spatial Planning and the Environment (respectively 2006 and 2007).

<sup>6</sup> ETBE and MTBE are ether compounds with the related recalcitrant property of being slow to biodegrade.

<sup>7</sup> Yeh en Novak, 1994. Anaerobic biodegradation of gasoline oxygenates in soils. *Water Environment Research*, Vol. 66, nr. 5, p. 744-752; Fayolle et al, 1998. Isolation of two aerobic bacterial strains that degrade efficiently ethyl t-butyl ether (ETBE), *Biotechnology Letters*, Vol. 20, no 3, p. 283-286.

<sup>8</sup> Koenen en Püttman, 2005. *Ersatz von MTBE durch ETBE: ein Vorteil für den Grundwasserschutz? Grundwasser – Zeitschrift der Fachsektion Hydrogeologie in der Deutschen Geologischen Gesellschaft* 4 p. 227-236.

According to data up to 2004, Spain and France are the biggest European manufacturers of ETBE. In 2004, the total production capacity of ETBE in Europe amounted to more than 1.3 million tonnes annually, which was about a third of the production capacity of MTBE in Europe. In various countries (including Poland and Germany), however, the volume of ETBE produced is increasing greatly as a result of the conversion of MTBE production sites to ETBE production sites. This is primarily the result of the European Directives intended to promote the use of biofuels.

The production capacity of ether compounds in fuels (particularly MTBE) is large in the Netherlands in comparison with other European countries (in the order of 1 million tonnes annually<sup>9</sup>). There was, however, no ETBE production in the Netherlands until a few years ago. The conversion of MTBE production sites to ETBE production sites has been taking place, and bio-ETBE has been admixed in certain petrols, in the Netherlands since 2006.

All the potential sources of ETBE contamination for groundwater have not, at yet, been mapped. The ETBE in groundwater has been monitored by several water companies for the last few years. An assessment and evaluation of these available data for groundwater is currently taking place on the instructions of Soil+ (Bodem+). The results are expected in the spring of 2008. In view of the comparable use of MTBE and ETBE, it is plausible that filling stations form potential sources of contamination, for example, by leakage from underground tanks. Other potential sources are the ETBE production sites, emission via road traffic and contaminated surface water. Because of the volatile nature of MTBE and ETBE, they can evaporate into the atmosphere and be spread diffusely in low concentrations via rainwater. A German study<sup>10</sup> measured average concentrations of MTBE in rainwater of 26 ng/l in urban areas and of 14 ng/l in rural areas.

Data obtained from monitoring the quality of surface water in the Rhineneighbourhood show that ETBE levels have been measured from around 2004. The concentrations show a clearly increasing trend. In 2006, concentrations were in the order of 1–10 µg/l. Increased levels of MTBE had already been ascertained in the river water some time prior to this. This contamination is attributed to the discharge of residual liquids by ships transporting MTBE and ETBE<sup>11</sup>.

There is growing attention at the European level for the environmental consequences of substances such as MTBE and ETBE. Both substances are being examined to see whether they should be given the status 'priority substance' within the framework of the Water Framework Directive. A Dutch member of the European Parliament (Dorette Corbey) recently submitted an amendment concerning the level of components such as MTBE and ETBE in diesel and petrol. The objective of this amendment is more detailed research into the link between the proportion of these components in fuels and the possible contamination of ground and surface water.

---

<sup>9</sup>According to data from the European Fuel Oxygenates Association (EFOA) and Lyondell from 2005 (Memorandum submitted by Lyondell, The United Kingdom Parliament, February 2006, [www.publications.parliament.uk/pa/cm200506/cmselect/cmenvaud/981/981we37.htm](http://www.publications.parliament.uk/pa/cm200506/cmselect/cmenvaud/981/981we37.htm))

<sup>10</sup>Achten, 2001. Methyl-*tert*-butyl ether (mtbe) in the aquatic environment in Germany. Dissertation, Johann Wolfgang Goethe-Universität Frankfurt am Main.

<sup>11</sup>Data presented at a meeting of the Internationale Arbeitsgemeinschaft der Rheinwasserwerke (IAWR) on 28 August 2007.

The TCB advises that the potential sources of contamination of groundwater with ETBE be mapped simultaneously with the study the Ministry of Housing, Spatial Planning and the Environment intends to have carried out into the origin of MTBE contamination.

It is important that, in addition to the point sources such as filling stations, a good picture is also obtained of the diffuse sources (for example, via surface water and atmospheric deposition). The TCB also recommends that the abovementioned assessment of measuring data of ETBE in groundwater be followed up by monitoring concentration developments in groundwater by means of a systematic monitoring programme.

#### A SINGLE UNIFORM REMEDIATION STANDARD

As indicated in the request for advice, the committee's opinion with regard to the choice of a uniform remediation standard is asked. The alternative is to lay down different remediation standards for, for example, in and outside drinking water catchment areas.

In view of the fact that the TCB attaches great importance to the protection of the groundwater in general<sup>12</sup>, it advocates the use of a single uniform remediation standard for ETBE. In doing so it supports the choice of the Minister of Housing, Spatial Planning and the Environment not to draw up a separate policy for drinking water catchment areas. Considerations taken into account here are the avoidance of shifting the risk elsewhere (given the mobility of groundwater) and the protection of the use of groundwater outside drinking water catchment areas, for example, for private wells, or for irrigation for agricultural purposes.

#### INFORMATION AVAILABLE FOR DERIVING A REMEDIATION STANDARD

In order to arrive at a realistic estimate of the risk limits for ETBE, the National Institute of Public Health and the Environment (RIVM) carried out a qualitative comparison of the properties and toxicity of ETBE and MTBE<sup>13</sup>. This qualitative comparison has been annexed to the request for advice. The RIVM has come to the conclusion that ETBE and MTBE do not differ much with regards to the risks for the public health and the ecosystem and that the risk limits of ETBE and MTBE are of the same order. The ecological risk limits and the odour and taste thresholds for ETBE are probably slightly lower than those for MTBE. The odour and taste thresholds for ETBE in groundwater will be lower than the human and ecological risk limits, as is the case for MTBE.

The TCB is, however, not aware of many studies on the odour and taste thresholds for ETBE in water. The references in the information provided with the request were also very limited. In a study carried out by the American Petroleum Institute in 1993<sup>14</sup> the odour and taste thresholds of both MTBE and ETBE in water were determined in accordance with a similar method, based on the observations of an odour and taste panel of at least six people. This study shows lower thresholds for ETBE than for MTBE. The odour

---

<sup>12</sup>See TCB reports *Advies Stysteemgericht grondwaterbeheer*, TCB S24(2003) and *Stysteemgericht grondwaterbeheer*, TCB R17(2003).

<sup>13</sup> Swartjes and Brand, *Kwalitatief vergelijk risicogrenzen voor ETBE and MTBE*. Memorandum from the National Institute of Public Health and the Environment (RIVM) to the Ministry of Housing, Spatial Planning and the Environment, 2 July 2007.

<sup>14</sup>Vetrano, K.M. 1993. Final report to ARCO Chemical Company on the odor and taste threshold studies performed with MTBE and ETBE. TRC Environmental Corporation Project No. 13442-M31.

thresholds in water for MTBE and ETBE were 193 µg/l and 106 µg/l respectively. The taste thresholds in water were 134 µg/l and 47 µg/l respectively. This study can be used to indicate the differences between the two substances, but is not sufficient to derive an odour or taste threshold for a remediation standard for ETBE. Additional research is required for this, given the variation generally found between the different studies.

An abstract of an American study carried out in 1997<sup>15</sup> gives a range of 2.5 to 100 µg/l at 20 °C for the odour threshold of ETBE in water. The original report from this study could not, however, be traced in public sources.

#### ADVICE

The TCB advises the laying down of a single uniform remediation standard that is equivalent to the odour (or taste) threshold for ETBE in groundwater.

In view of the increase in the volume of ETBE being produced in Europe, the expected enormous increase in its use in the Netherlands and its properties, the TCB considers it advisable to anticipate these developments by, amongst other things, laying down standards. It is, however, of the opinion that there is still too little information available to it to lay down a remediation standard for ETBE and is therefore unable to give any advice on the magnitude of such a remediation standard. The available data suggest that the odour and taste thresholds will be in the same order as those for MTBE. The TCB feels that an additional assessment of the available data, and perhaps additional studies, are necessary for the laying down of a well-founded odour or taste threshold for groundwater. It should be noted here that the RIVM is currently carrying out an additional study into the odour and taste thresholds of ETBE, in which panels of selected test subjects are being used.

In view of the similarity in chemical structure of ETBE and TBE, the TCB finds it important to examine whether there is any mutual influence of the odour and taste thresholds of these and any other oxygenates (such as *tert*-amyl-methyl-ether, AME) if groundwater is contaminated with these substances. If there is significant mutual influence, the TCB advises that a remediation standard be laid down for the total of these substances.

Yours faithfully,  
Chairman, Soil Protection Technical Committee,



L.E. Stolker-Nanninga.

---

<sup>15</sup> Shen, Y.F., Yoo, L.J., Fitzsimmons, S.R. and Yamamoto, M.K. (1997). Orange County Water District. Threshold Odor Concentrations of MTBE and Other Fuel Oxygenates.