

Chapter 8: EPTC

A chapter from:

**Regulatory Determinations Support Document for Selected Contaminants
from the Second Drinking Water Contaminant Candidate List (CCL 2)**

EPA Report 815-R-08-012

Executive Summary

s-Ethyl dipropylthiocarbamate (EPTC), a synthetic organic compound (SOC), is a thiocarbamate herbicide used to control weed growth during the pre-emergence and early post-emergence stages of weed germination. First registered for use in 1958, EPTC is used across the U.S. in the agricultural production of a number of crops, most notably corn, potatoes, dried beans, alfalfa, and snap beans. EPTC is also used residentially on shade trees, annual and perennial ornamentals, and evergreens.

Environmental fate data indicate that EPTC would not be persistent under most environmental conditions. Volatilization into the atmosphere and degradation by soil organisms appear to be the primary dissipation routes. EPTC has a low affinity for binding to the soil so the potential to leach to ground water does exist. If EPTC reaches ground water, volatilization is less likely to occur.

In subchronic and chronic studies performed in both rats and dogs, EPTC exposure produced dose-related increases in the incidence and severity of cardiomyopathy, a disorder of the heart muscle, and degenerative effects (neuronal and/or necrotic degeneration) in the central and peripheral nervous system. Based on a no-observed-adverse-effect level (NOAEL) of 2.5 mg/kg/day from a study that found cardiomyopathy at higher doses, the Environmental Protection Agency (EPA) derived a reference dose (RfD) of 0.025 mg/kg/day for EPTC. This value was calculated using an uncertainty factor of 100 for inter- and intraspecies differences. The Agency derived the health reference level (HRL) for EPTC using the RfD of 0.025 mg/kg/day and a 20 percent relative source contribution. The HRL is calculated to be 0.175 mg/L or 175 µg/L.

The Agency used long-term studies in mice and rats and short-term studies of mutagenicity to evaluate the potential for EPTC carcinogenicity. Based on these data and using EPA's 1999 Guidelines for Carcinogen Risk Assessment, EPA considers EPTC unlikely to be carcinogenic to humans.

Available data do not suggest increased pre- or post-natal sensitivity of children and infants to EPTC exposure.

Estimates of EPTC usage in the United States suggest a decline from approximately 17 to 21 million pounds in 1987 to approximately 7 to 9 million pounds in 1999. Toxic Release Inventory (TRI) data from 1995 to 2003 indicate that most on-site industrial releases of EPTC tend to be releases to air and underground injections. Surface water discharges are minimal in comparison.

Data on the ambient occurrence of EPTC are available from the first monitoring cycle (1992-2001) of the United States Geological Survey's (USGS's) National Ambient Water Quality Assessment (NAWQA) program. While USGS detected EPTC in both surface and ground waters, in no land use setting did the 95th percentile concentration of EPTC exceed 0.018 µg/L. The estimated maximum surface water concentration, 29.6 µg/L (from a mixed land use setting), and the maximum ground water concentration, 0.45 µg/L (from an agricultural setting), are both less than the EPTC HRL and ½ the HRL.

To determine the extent of EPTC contamination in drinking water, EPA included EPTC as an analyte in the First Unregulated Contaminant Monitoring Regulation (UCMR 1). None of the 3,873 public water systems (PWSs) sampled (serving a total population of 226 million) had detects of EPTC at or above the MRL of 1 µg/L. Hence, these data indicate that no occurrence and exposure is expected in drinking water at levels greater than the HRL (175 µg/L), or even ½ the HRL (87.5 µg/L).

EPA also evaluated sources of supplemental information on EPTC occurrence in drinking water. The National Pesticide Survey (NPS) collected samples from approximately 1,300 community water systems and rural drinking water wells between 1988 and 1990. EPTC was not detected using a minimum reporting limit of 0.15 µg/L. The Pesticides in Ground Water Database indicates that EPTC was found in 2 of 1,752 ground water wells that were sampled in 10 States. Both contaminated wells were in Minnesota. The detected concentrations ranged from 0.01 to 0.33 µg/L. No detections exceeded the HRL or ½ the HRL.

The Agency has made a determination not to regulate EPTC with a national primary drinking water regulation (NPDWR). Because EPTC does not appear to occur at health levels of concern in PWSs, the Agency believes that an NPDWR does not present a meaningful opportunity for health risk reduction.

The Agency's regulatory determination for this contaminant is presented formally in the *Federal Register*.

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Abbreviations

a.i.	Active Ingredient
AOAC	Association of Analytical Communities
APHA	American Public Health Association
ASTM	American Society for Testing and Materials
CAS	Chemical Abstracts Service
CCL 2	Second Contaminant Candidate List
ChE	Cholinesterase
CWS	Community Water System
EPTC	s-Ethyl dipropylthiocarbamate
ESO	EPTC sulfoxide
FQPA	Food Quality Protection Act
GAC	Granular Activated Carbon
GC	Gas Chromatography
GC/MS	Gas Chromatography with Mass Spectrometry
GW	Ground Water
HRL	Health Reference Level
LSE	Liquid-Solid Extraction
MDL	Method Detection Limit
MRL	Minimum Reporting Level
MTBE	Methyl Tertiary Butyl Ether
NAWQA	National Water Quality Assessment
NCFAP	National Center for Food and Agricultural Policy
NOAEL	No-Observed-Adverse-Effect Level
NPD	Nitrogen-Phosphorus Detector
NPDWR	National Primary Drinking Water Regulation
NPS	National Pesticide Survey
NTNCWS	Non-Transient Non-Community Water System
OPP	Office of Pesticide Programs
PGWDB	Pesticides in Ground Water Database
PWS	Public Water System
RfD	Reference Dose
RL	Reporting Limit
RO	Reverse Osmosis
SOC	Synthetic Organic Compound
SW	Surface Water
TRI	Toxics Release Inventory
UCMR 1	First Unregulated Contaminant Monitoring Regulation
USGS	United States Geological Survey

8 EPTC

8.1 Definition

s-Ethyl dipropylthiocarbamate (EPTC) is a thiocarbamate (a carbamate in which the -CO- group has been replaced by a -CS- group) herbicide. It is included in the category of synthetic organic compounds (SOCs). Synonyms include: S-ethyl dipropyl-thiocarbamate, R-1608, FDA 1541, and Eptam (Windholz, 1983). Additional trade names include Alirox, Eradicane, Eradicane Extra, Genep, Genep Plus, and Shortstop. It has no predominant isomers. EPTC's Chemical Abstracts Service (CAS) registry number is 759-94-4.

8.1.1 Properties and Sources

EPTC is a colorless or yellow liquid with a characteristic odor. It is a synthetic product and does not occur naturally. The predominant use of EPTC is as a selective herbicide. EPTC is used for control of annual grassy weeds, perennial weeds, and some broadleaf weeds in the cultivation of beans, forage legumes, potatoes, corn, and sweet potatoes. EPTC is produced in several ways, but commonly by the reaction of dipropylamine with ethyl chlorothioformate (HSDB, 2004). Some physical and chemical properties of EPTC are listed in Exhibit 8-1.

Exhibit 8-1: Physical and Chemical Properties of EPTC

Identification	
CAS number	759-94-4
Molecular Formula	C ₉ H ₁₉ NOS
Physical and Chemical Properties	
Boiling Point	127 °C at 20 mm Hg ¹
Melting Point	-----
Molecular Weight	189.31 g/mol ¹
Log K _{OC}	2.23 - 2.45 ²
Log K _{OW}	3.21 ³
Water Solubility	367 mg/L at 25 °C ⁴
Vapor Pressure	2.4 x 10 ⁻² mm Hg at 25 °C ⁵
Henry's Law Constant	1.6 x 10 ⁻⁵ atm-m ³ /mol ² 9.8 x 10 ⁻⁴ (dimensionless), predicted ⁶ 6.5 x 10 ⁻⁴ (dimensionless), from literature ⁶
Freundlich Isotherm Constant (K)	79,500 (µg/g)(L/µg) ^{1/n} ⁶

¹ Tomlin, 1997 (as cited in HSDB, 2004)

² HSDB, 2004

³ Hansch et al., 1995 (as cited in HSDB, 2004)

⁴ Yalkowsky and Dannenfelser, 1992 (as cited in HSDB, 2004)

⁵ USDA, 2000 (as cited in HSDB, 2004)

⁶ Speth et al., 2001

8.1.2 Environmental Fate and Behavior

Microbial degradation and volatilization are the primary environmental pathways of EPTC in soil. EPTC is readily lost from soil surfaces by volatilization if not incorporated into the soil upon application. Terrestrial field dissipation studies report soil half-lives between 2 to 18.8 days. Judging by its water solubility of 367 mg/L and its low affinity for binding to soil, EPTC also has a moderate potential to leach into ground water during this short window. Abiotic hydrolysis, direct photolysis, and photodegradation are not major degradation routes. EPTC is somewhat more persistent in anaerobic soils than in aerobic soils. (USEPA, 1999a).

EPTC is likely to persist longer in ground waters than in surface waters due to its relatively high volatility (USEPA, 1999a). Microbial degradation is also expected to be a significant pathway in aquatic environments, but there have been no studies to confirm this (USEPA, 1999a).

EPTC in the atmosphere is expected to remain primarily in the vapor phase. Atmospheric EPTC may degrade by reaction with photochemically produced hydroxyl radicals and may also be subject to wet deposition, potentially contaminating nonagricultural sites and surface waters (USEPA, 1999a).

The primary environmental degradates of EPTC are EPTC sulfoxide (ESO) and dipropylamine. ESO is formed during oxidation of EPTC, the first step of the compound's breakdown. Subsequent sulfur and carbon oxidation produces dipropylamine. Other degradation pathways have also been proposed (USEPA, 1999a). Half-lives for ESO and dipropylamine in soil have been estimated at 13-14 days and 7 days, respectively. While environmental fate data for EPTC degradates are limited, available data suggest that ESO and dipropylamine may be less mobile than the parent compound (USEPA, 1999a).

8.2 Health Effects

In acute animal toxicity studies, EPTC was shown to be moderately toxic via oral and dermal routes and highly toxic via inhalation exposures. EPTC is a reversible cholinesterase (ChE) inhibitor. Similar to other thiocarbamates, it does not produce a consistent ChE inhibition profile. There was no consistent pattern observed in any of the toxicity studies with regard to species, duration of treatment, or the type of ChE enzyme measured. Typically, studies showed inhibition of plasma ChE with dose-related decreases in red blood cell and brain ChE activity. Some studies have shown that brain ChE activity was inhibited without any effect on either plasma or erythrocyte ChE activities. Other studies illustrated erythrocyte ChE inhibition with no effect on either plasma or brain ChE (USEPA, 1999a). In a primary eye irritation study in rabbits, technical grade EPTC was shown to be slightly irritating (USEPA, 1999a).

In subchronic and chronic studies performed in both rats and dogs, there was a dose-related increase in the incidence and severity of cardiomyopathy, a disorder of the heart muscle (Mackenzie, 1986 as cited in USEPA, 1999a; USEPA, 1999a). An increase in the incidence and severity of degenerative effects (neuronal and/or necrotic degeneration) in both the central and peripheral nervous system was observed in rats and dogs following exposure to EPTC (USEPA, 1999a).

EPA derived a reference dose (RfD) of 0.025 mg/kg/day for EPTC (USEPA, 1990a; USEPA, 1999a). This value was calculated using a no-observed-adverse-effect level (NOAEL) of 2.5 mg/kg/day from a study by Mackenzie (1986 as cited in USEPA, 1999a). An uncertainty factor of 100 was applied for inter- and intraspecies differences. The critical effect associated with the RfD is cardiomyopathy (disease of the heart muscle). In the reregistration of EPTC, the application of a ten-fold Food Quality Protection Act (FQPA) factor was recommended in order to be protective against residential exposures of infants and children. The Agency derived the health reference level (HRL) for EPTC using the RfD of 0.025 mg/kg/day and a 20 percent relative source contribution. The HRL is calculated to be 0.175 mg/L or 175 µg/L.

The Agency used long-term studies in mice and rats and short-term studies of mutagenicity to evaluate the potential for carcinogenicity (USEPA, 1990a). Based on these data and using EPA's 1999 Guidelines for Carcinogen Risk Assessment, EPTC is not likely to be carcinogenic to humans (USEPA, 1999b).

EPA also evaluated whether health information is available regarding the potential effects on children and other sensitive populations. Data do not suggest increased pre- or post-natal sensitivity of children and infants to EPTC exposure. In animal studies, adverse developmental effects (i.e., decreased fetal body weight and decreased litter size) were only seen at doses that were toxic to the mother (USEPA, 1999a). Results from both developmental and reproductive studies indicate that there are only minimal adverse effects. The behavior patterns of children that lead to heightened opportunities for exposure in the indoor environment and the need for a developmental neurotoxicity study lead the Office of Pesticide Programs (OPP) to recommend the application of a ten-fold FQPA factor for EPTC. However, EPA did not apply this factor in the screening analysis because it does not apply to programs other than the pesticide registrations.

8.3 Occurrence and Exposure

8.3.1 Use and Environmental Release

EPTC is a thiocarbamate herbicide used in the pre-emergence and early post-emergence stages of weed germination to control weed growth. It was first registered for use in the United States in 1958. It is in widespread use across the United States in agricultural production of a number of crops, most notably corn, potatoes, dried beans, alfalfa, and snap beans. EPTC is also used residentially on shade trees, annual and perennial ornamentals, and evergreens. EPTC can be applied as a spray, as a granular formulation, or via chemigation. EPTC was initially manufactured in Hungary and imported into the United States. Currently, Zeneca Ag Products holds registrations for a number of end-use products and is the sole registration for the technical product in the United States (USEPA, 1999a).

According to EPA statistics from 1987 through 1999, EPTC use in the United States has been declining. In 1999, it was the nineteenth most commonly used active ingredient (a.i.) in U.S. agriculture, down from eighth in 1987 and twelfth in 1993 (USEPA, 2002). According to one analysis, the annual total domestic usage of EPTC between 1987 and 1996 averaged approximately 20 million pounds a.i. for almost 6 million acres treated (USEPA, 1999a). In 2002, EPA concluded that the usage range in 1999 had fallen to between 7 and 9 million pounds a.i., down from 17 to 21 million pounds a.i. in 1987 and 10 to 15 million pounds a.i. in 1993 (USEPA, 2002).

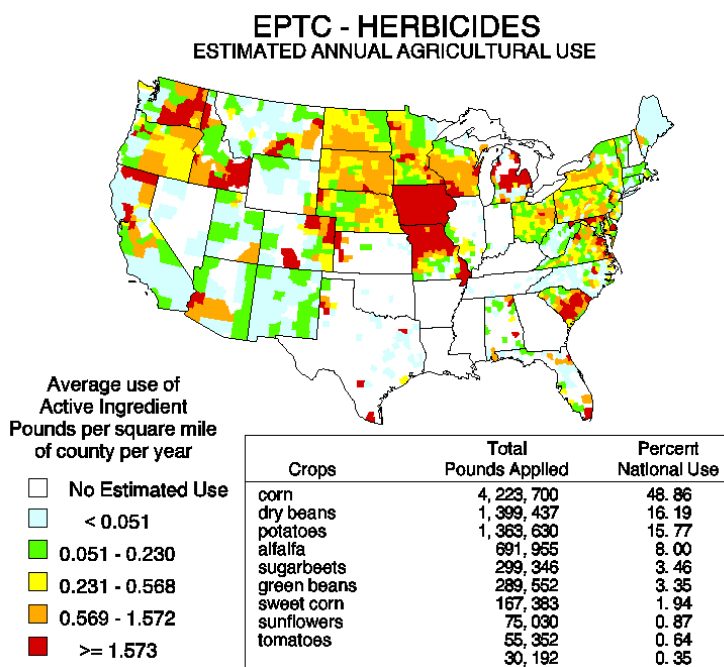
The National Center for Food and Agricultural Policy (NCFAP) estimates of national agricultural ETPC use confirm a decline during the 1990s. According to NCFAP, around 1992 approximately 14.5 million pounds a.i. of EPTC were applied annually to 14 types of crops on 4.0 million acres, and around 1997 approximately 8.8 million pounds a.i. were applied annually to 14 types of crops on 2.6 million acres. NCFAP estimates are based on State-level commercial agriculture usage patterns for the periods 1990-1993 and 1995-1998, and State-level crop acreage for 1992 and 1997 (NCFAP, 2004). For more information on NCFAP pesticide use estimates, see Chapter 2.

The United States Geological Survey (USGS) combined data collected by NCFAP with data from the Census of Agriculture to estimate that 14.1 million pounds of EPTC a.i. per year

were used on approximately 4.0 million agricultural acres in the early 1990s (Thelin and Gianessi, 2000). While USGS has not published national estimates for 1997, an estimate of approximately 8.6 million pounds a.i. can be inferred from the “total pounds applied” and “percent national use” data in the 1997 geographical distribution map (see Exhibit 8-2).

Exhibit 8-2 shows the estimated geographic distribution and intensity of typical annual EPTC use in the United States in the late 1990s. A breakdown of use by crop is also included. The map was created by USGS using State-level data sets on pesticide use rates from 1995-1998 compiled by NCFAP, combined with county-level data on harvested crop acreage obtained from the 1997 Census of Agriculture (USGS, 2004). Due to the nature of the data sources, non-agricultural uses are not reflected on the map and variations in use at the county-level are also not well represented (Thelin and Gianessi, 2000). For background on the USGS pesticide use maps, see Chapter 2. The map indicates that EPTC use is widespread, especially in the East, the Northern Great Plains, and the West.

Exhibit 8-2: Estimated Annual Agricultural Use of EPTC, c. 1997



Source: USGS, 2004

Toxics Release Inventory (TRI) data for EPTC (see Exhibit 8-3) are reported for the years 1995 to 2003 (USEPA, 2006). Total reported EPTC releases fluctuated widely in the range of thousands of pounds per year during this period. On-site releases were dominated by air emissions and sometimes underground injections. On-site surface water releases did not exceed 300 pounds per year; no land releases were reported. Off-site releases were significant, but declined steadily after 1998. Releases were reported from seven States during the eight-year

period on record. Releases were reported from Alabama, Nebraska, and Louisiana every year or nearly every year. For a discussion of the nature and limitations of TRI data, see Chapter 2.

Exhibit 8-3: Environmental Releases (in Pounds) of EPTC in the United States, 1995-2003

Year	On-Site Releases				Off-Site Releases	Total On- & Off-site Releases
	Air Emissions	Surface Water Discharges	Underground Injection	Releases to Land		
1995	2,363	291	373	0	9,366	12,393
1996	7,325	2	29	0	590	7,946
1997	2,208	113	9,501	0	2,778	14,600
1998	2,008	115	2,088	0	4,565	8,776
1999	2,574	156	903	0	3,570	7,203
2000	2,034	95	6,083	0	2,798	11,010
2001	2,034	99	1,146	0	1,655	4,934
2002	1,917	98	0	0	708	2,723
2003	1,575	95	0	0	513	2,183

Source: USEPA, 2006

8.3.2 Ambient Water Occurrence

Ambient lakes, rivers, and aquifers are the source of most drinking water. Data on the occurrence of EPTC in ambient surface and ground water are available from the National Water Quality Assessment (NAWQA) program of the USGS. For details on this program, see the discussion in Chapter 2. NAWQA data have been analyzed independently by USGS and EPA.

NAWQA National Pesticide Synthesis

Under the NAWQA program, USGS monitored EPTC between 1992 and 2001 in representative watersheds and aquifers across the country. Reporting limits (RLs) varied but did not exceed 0.002 µg/L.

In surface water (Exhibit 8-4), EPTC was detected at frequencies ranging from 1.64% of samples in undeveloped settings to 4.81% in urban land use settings, 11.88% in mixed land use settings, and 14.11% in agricultural settings. The 95th percentile concentrations were less than the reporting limit in undeveloped and urban settings, 0.009 µg/L in mixed land use settings, and 0.018 µg/L in agricultural settings. The highest concentration, estimated at 29.6 µg/L, was found in a mixed land use setting (Martin *et al.*, 2003).

Exhibit 8-4: USGS National Synthesis Summary of NAWQA Monitoring of EPTC in Ambient Surface Water, 1992-2001

Land Use Type	No. of Samples (and No. of Sites)	Detection Frequency	50 th Percentile (Median) Concentration	95 th Percentile Concentration	Maximum Concentration
Agricultural	1,884 (78)	14.11%	<RL	0.018 µg/L	7.30 µg/L
Mixed	1,000 (47)	11.88%	<RL	0.009 µg/L	29.6 µg/L (E)
Undeveloped	60 (4)	1.64%	<RL	<RL	0.004 µg/L
Urban	892 (33)	4.81%	<RL	<RL	0.038 µg/L

Notes:

RL = Reporting limit. Reporting limits for EPTC varied, but did not exceed 0.002 µg/L.

E = Estimated (outside normal calibration limits)

The USGS Pesticide National Synthesis used one year of data, generally the year with the most sampling results, to represent each site in this analysis. The sampling results were time-weighted, to eliminate bias from more frequent sampling at certain times of year. Detection Frequencies and Percentile Concentrations can be interpreted as representing annual occurrence. For instance, the detection frequency can be thought of as the percent of the year in which detections are found at a typical site in this land use category, and the 95th percentile concentration can be thought of as a concentration that is not exceeded for 95% of the year at a typical site in this land use category.

Source: Martin et al., 2003

In ground water (Exhibit 8-5), EPTC detection frequencies ranged from 0.0% in undeveloped settings to 0.33% in mixed land use (major aquifer) settings, 0.49% in agricultural settings, and 0.72% in urban settings. The 95th percentile concentrations were less than the reporting limit in all settings. The highest concentration, 0.45 µg/L, was found in an agricultural setting (Kolpin and Martin, 2003).

Exhibit 8-5: USGS National Synthesis Summary of NAWQA Monitoring of EPTC in Ambient Ground Water, 1992-2001

Land Use Type	No. of Wells	Detection Frequency	50 th Percentile (Median) Concentration	95 th Percentile Concentration	Maximum Concentration
Agricultural	1,443	0.49%	<RL	<RL	0.45 µg/L
Mixed (Major Aquifer)	2,717	0.33%	<RL	<RL	0.182 µg/L
Undeveloped	67	0.0%	<RL	<RL	<RL
Urban	834	0.72%	<RL	<RL	0.02 µg/L

Notes:

RL = Reporting limit. Reporting limits for EPTC varied, but did not exceed 0.002 µg/L.

The USGS Pesticide National Synthesis considered each well a distinct site in this analysis. Each well was represented by one sample: normally the first one taken, but possibly a later sample if the first sample was not analyzed for the full range of analytes.

Percentile Concentrations were drawn from the range of detects and non-detects. The method for calculating Percentile Concentrations varied depending on how much of the data was censored at particular levels by the laboratory.

Source: Kolpin and Martin, 2003

EPA Summary Analysis of NAWQA Data

Whereas the NAWQA program often uses the most representative data for a site to calculate summary statistics, EPA, with the cooperation of USGS, has performed a summary analysis of all Cycle 1 water monitoring data from all study units (1991-2001) for many of the Second Contaminant Candidate List (CCL 2) contaminants being considered for regulatory determination, including EPTC. Detection frequencies were simply computed as the percentage of samples and sites with detections (i.e., with at least one result equal to or greater than the reporting limit). Note that reporting limits were not uniform. Sample detections can be biased by frequent sampling in areas with high (or low) occurrence. Calculating the percentage of sites with detections can reduce this bias. For more details on the data set and the EPA analysis, see Chapter 2.

The results of the EPA analysis are presented in Exhibit 8-6. Overall, EPTC was detected in 10.5% of samples and at 5.7% of sites. EPTC was detected more frequently and at higher concentrations (maximum of 40 µg/L) in surface water.

Exhibit 8-6: EPA Summary Analysis of EPTC Data from NAWQA Study Units, 1992-2001

	Detection Frequency (detections are results \geq RL ¹)				Concentration Values (of detections, in $\mu\text{g/L}$)				
	Number of Samples	% Samples with Detections	Number of Sites	% Sites with Detections	Minimum	Median	95 th Percen- tile	99 th Percen- tile	Maximum
surface water	14,872	14.4%	1,907	18.9%	0.0004	0.01	0.199	1.5	40
ground water	6,080	0.9%	5,211	0.9%	0.001	0.006	0.17	0.45	0.45
all sites	20,952	10.5%	7,118	5.7%	0.0004	0.01	0.19	1.5	40

¹RLs (Reporting Limits) for EPTC varied, but did not exceed 0.002 $\mu\text{g/L}$. For more information, see Chapter 2. Note that because this EPA analysis involves more data points than the USGS analyses presented above, a direct comparison is not possible.

8.3.3 Drinking Water Occurrence

Nationally representative data on EPTC occurrence in drinking water have been collected by large and small public water systems in accordance with EPA's First Unregulated Contaminant Monitoring Regulation (UCMR 1). For details on UCMR 1, see Chapter 2 and USEPA (2008).

UCMR 1

UCMR 1 monitoring was conducted primarily between 2001 and 2003, though some results were not collected and reported until as late as 2006. As a List 1 contaminant, EPTC was scheduled to be monitored by all large community water systems (CWSs) and non-transient non-community water systems (NTNCWSs) and a statistically representative sample of small CWSs and NTNCWSs. The data presented in this report reflect UCMR 1 analytical samples submitted and quality-checked under the regulation as of March 2006. EPTC data were collected and submitted by 797 (99.6 percent) of the 800 small systems selected for the small system sample and 3,076 (99.2 percent) of the 3,100 large systems defined as eligible for the UCMR 1 large system census. EPTC data have been analyzed at the level of simple detections (at or above the minimum reporting level (MRL), \geq MRL, or $\geq 1 \mu\text{g/L}$), exceedances of the health reference level ($>$ HRL, or $> 175 \mu\text{g/L}$), and exceedances of one-half the value of the HRL ($> \frac{1}{2}$ HRL, or $> 87.5 \mu\text{g/L}$).

Results of the analysis are presented in Exhibits 8-7 and 8-8. No detections of EPTC were found in any samples, and thus there were also no exceedances of the HRL or one-half the HRL.

Exhibit 8-7: Summary UCMR 1 Occurrence Statistics for EPTC in Small Systems (Based on Statistically Representative National Sample of Small Systems)

Frequency Factors	UCMR Data - Small Systems		National System & Population Numbers ¹
Total Number of Samples	3,251		--
Percent of Samples with Detections	0.00%		--
99 th Percentile Concentration (all samples)	< MRL		--
Health Reference Level (HRL)	175 µg/L		--
Minimum Reporting Level (MRL)	1 µg/L		--
Maximum Concentration of Detections	< MRL		--
99 th Percentile Concentration of Detections	< MRL		--
Median Concentration of Detections	< MRL		--
Total Number of PWSs	797		60,414
Number of GW PWSs	590		56,072
Number of SW PWSs	207		4,342
Total Population	2,760,570		45,414,590
Population of GW PWSs	1,939,815		36,224,336
Population of SW PWSs	820,755		9,190,254
Occurrence by System	Number	Percentage	National Extrapolation ²
PWSs (GW & SW) with Detections (≥ MRL)	0	0.00%	0
PWSs (GW & SW) > 1/2 HRL	0	0.00%	0
PWSs (GW & SW) > HRL	0	0.00%	0
Occurrence by Population Served			
Population Served by PWSs with Detections	0	0.00%	0
Population Served by PWSs > 1/2 HRL	0	0.00%	0
Population Served by PWSs > HRL	0	0.00%	0

1. Total PWS and population numbers are from EPA September 2004 Drinking Water Baseline Handbook, 4th edition.

2. National extrapolations are generated separately for each population-served size stratum and then added to yield the national estimate of GW PWSs with detections (and population served) and SW PWSs with detections (and population served). For intermediate calculations at the level of individual strata, see EPA's UCMR 1 Occurrence Report, entitled "The Analysis of Occurrence Data from the First Unregulated Contaminant Monitoring Regulation (UCMR 1) in Support of Regulatory Determinations for the Second Drinking Water Contaminant Candidate List."

Abbreviations:

PWS = Public Water Systems; GW = Ground Water; SW = Surface Water; N/A = Not Applicable; Total Number of Samples = the total number of samples on record for the contaminant; 99th Percentile Concentration = the concentration in the 99th percentile sample (out of either all samples or just samples with detections); Median Concentration of Detections = the concentration in the median sample (out of samples with detections); Total Number of PWSs = the total number of PWSs for which sampling results are available; Total Population Served = the total population served by PWSs for which sampling results are available; PWSs with detections, PWSs > 1/2 HRL, or PWSs > HRL = PWSs with at least one sampling result greater than or equal to the MRL, exceeding the 1/2 HRL benchmark, or exceeding the HRL benchmark, respectively; Population Served by PWSs with detections, by PWSs > 1/2 HRL, or by PWSs > HRL = population served by PWSs with at least one sampling result greater than or equal to the MRL, exceeding the 1/2 HRL benchmark, or exceeding the HRL benchmark, respectively.

Notes:

-Small systems are those that serve 10,000 persons or fewer.

-Only results at or above the MRL were reported as detections. Concentrations below the MRL are considered non-detects.

Exhibit 8-8: Summary UCMR 1 Occurrence Statistics for EPTC in Large Systems (Based on the Census of Large Systems)

Frequency Factors	UCMR Data - Large Systems	
Total Number of Samples	30,547	
Percent of Samples with Detections	0.00%	
99 th Percentile Concentration (all samples)	< MRL	
Health Reference Level (HRL)	175 µg/L	
Minimum Reporting Level (MRL)	1 µg/L	
Maximum Concentration of Detections	< MRL	
99 th Percentile Concentration of Detections	< MRL	
Median Concentration of Detections	< MRL	
Total Number of PWSs	3,076	
Number of GW PWSs	1,380	
Number of SW PWSs	1,696	
Total Population	223,491,907	
Population of GW PWSs	53,405,539	
Population of SW PWSs	170,086,368	
Occurrence by System	Number	Percentage
PWSs (GW & SW) with Detections (\geq MRL)	0	0.00%
PWSs (GW & SW) > 1/2 HRL	0	0.00%
PWSs (GW & SW) > HRL	0	0.00%
Occurrence by Population Served		
Population Served by PWSs with Detections	0	0.00%
Population Served by PWSs > 1/2 HRL	0	0.00%
Population Served by PWSs > HRL	0	0.00%

Abbreviations:

PWS = Public Water Systems; GW = Ground Water; SW = Surface Water; N/A = Not Applicable; Total Number of Samples = the total number of samples on record for the contaminant; 99th Percentile Concentration = the concentration in the 99th percentile sample (out of either all samples or just samples with detections); Median Concentration of Detections = the concentration in the median sample (out of samples with detections); Total Number of PWSs = the total number of PWSs for which sampling results are available; Total Population Served = the total population served by PWSs for which sampling results are available; PWSs with detections, PWSs > 1/2 HRL, or PWSs > HRL = PWSs with at least one sampling result greater than or equal to the MRL, exceeding the 1/2 HRL benchmark, or exceeding the HRL benchmark, respectively; Population Served by PWSs with detections, by PWSs > 1/2 HRL, or by PWSs > HRL = population served by PWSs with at least one sampling result greater than or equal to the MRL, exceeding the 1/2 HRL benchmark, or exceeding the HRL benchmark, respectively.

Notes:

-Large systems are those that serve more than 10,000 persons.

-Only results at or above the MRL were reported as detections. Concentrations below the MRL are considered non-detections.

Summary Analysis of Combined Large and Small System UCMR 1 Data

None of the 3,873 Public Water Systems (PWSs) sampled (serving a population of 226 million) had detects of EPTC at the MRL of 1 µg/L. Hence, these data indicate that no occurrence and exposure is expected at levels greater than 87.5 µg/L (½ the HRL) and greater than 175 µg/L (the HRL).

Pesticides in Ground Water Database (PGWDB)

The Pesticides in Ground Water Database (PGWDB) is a compilation of data from ground water studies conducted by federal, State, and local governments, the pesticide industry, and other institutions between 1971 and 1991 (USEPA, 1992). Most of the data are from drinking water wells. Since PGWDB data come from multiple sources, they should be interpreted with caution. Results might be biased high, because areas with suspected contamination are likely to have been sampled more frequently than pristine areas. For more background to the PGWDB, see Chapter 2.

According to the data compiled in the PGWDB, EPTC was found in 2 (0.11 percent) of 1,752 ground water wells that were sampled in 10 States. Both contaminated wells were in Minnesota. The detected concentrations ranged from 0.01 to 0.33 µg/L (USEPA, 1992).

National Pesticide Survey (NPS)

EPA collected samples from approximately 1,300 CWS wells and rural drinking water wells between 1988 and 1990 for the National Pesticide Survey (NPS). The survey was designed to provide a statistically reliable estimate of pesticide occurrence in the nation's drinking water wells. For details about NPS, see Chapter 2.

With a minimum reporting limit of 0.15 µg/L, EPTC was not detected in the survey (USEPA, 1990b).

8.4 Technology Assessment

8.4.1 Analytical Methods

EPA evaluated the availability of analytical methods for all of the unregulated contaminants considered for UCMR 1 (64 FR 50556). Sources for these methods include publications by EPA and by voluntary consensus standard organizations such as the American Society for Testing and Materials (ASTM), the Association of Analytical Communities (AOAC), and the American Public Health Association (APHA).

EPTC is a UCMR 1 List 1 contaminant that can be detected in drinking water by EPA Methods 507 and 525.2. These methods were approved for the monitoring of EPTC in 1999 (64 FR 50556). EPA Method 507 relies on solvent extraction of EPTC and separation by gas chromatography (GC) with a nitrogen-phosphorus detector (NPD), while EPA Method 525.2 relies on liquid-solid extraction and capillary column gas chromatography/ mass spectrometry (GC/MS). A full description of EPA Methods 507 and 525.2 can be found in EPA's *Methods for*

the Determination of Organic Compounds in Drinking Water, Supplement 3 (USEPA, 1995a). Additional methods approved for EPTC include ASTM Method D5475-93 (ASTM, 1996; 1998) and AOAC 991.07 (AOAC, 1998).

The method detection limit (MDL) and the average recovery for each analytical method used that can be used for the analysis of EPTC in water are included in the method descriptions below.¹

EPA Method 507

In EPA Method 507 (Revision 2.1), “*Determination of Nitrogen and Phosphorus-Containing Pesticides in Water by Gas Chromatography with a Nitrogen-Phosphorus Detector*,” a sample is extracted with methylene chloride by shaking in a separatory funnel. The methylene chloride extract is separated, dried, and concentrated during a solvent exchange to methyl tertiary butyl ether (MTBE). Chromatographic conditions are set to allow for separation and measurement of the analytes in the extract by capillary column GC with a NPD (USEPA, 1995b).

The MDL for EPTC is 0.08 µg/L. The average recovery for EPTC ranges from 83 to 86 percent depending on the method option used (USEPA, 1995b).

EPA Method 525.2

In EPA Method 525.2 (Revision 2.0), “*Determination of Organic Compounds in Drinking Water by Liquid-Solid Extraction and Capillary Column Gas Chromatography/Mass Spectrometry*,” a water sample is passed through a disk or cartridge containing a solid matrix with a chemically bonded C₁₈ organic phase. This is known as liquid-solid extraction (LSE). The organic compounds are eluted from the LSE disk or cartridge with small amounts of ethyl acetate and methylene chloride. The analytes are then concentrated by evaporation of some of the solvent. The concentrated extract is analyzed by injecting an aliquot of the extract into the high resolution fused silica capillary column of a GC/MS system. Compounds eluting from the GC column are characterized by comparing their measured mass spectra and retention times against reference mass spectra and retention times (USEPA, 1995c).

¹ The Method Detection Limit (MDL) is a statistical estimate of the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero, *i.e.*, greater than the background signal. The calculation of the MDL is based upon the precision of a series of replicate measurements of the analyte at low concentrations. The MDL incorporates estimates of the accuracy of the determination. The MDL is not a concentration that can typically be measured by the method on a routine basis. Detection limits may vary between analysts and laboratories under various laboratory conditions.

The average recovery is the fraction or percent concentration of a target analyte determined relative to the true or expected concentration from a sample containing a known amount of the target analyte. (This can result in apparent recovery values greater than 100 percent.)

The MDL for EPTC in reagent water ranges from 0.056 to 0.12 µg/L, depending on the method option used. The average recovery is reported to range from 97 to 105 percent depending on the method option used (USEPA, 1995c).

8.4.2 Treatment Technologies

Treatment technology status does not influence the determination of whether or not a contaminant should be regulated. However, treatment technologies must be readily available before a contaminant can be regulated with a national primary drinking water regulation (NPDWR). There is no evidence that EPTC is substantially removed by conventional treatments, such as coagulation/flocculation, sedimentation, and inert media filtration. Microbial breakdown has been reported to be a major degradation pathway in soils (Ahrens, 1994 as cited in HSDB, 2004), which suggests the possibility of biological treatment. However, no testing has been done on the biological removal of EPTC from water. Other potential treatment technologies include activated carbon and reverse osmosis.

Granular activated carbon (GAC) treatment removes contaminants via the physical and chemical process of sorption: the contaminants attach to the carbon surface as water passes through the carbon bed. Activated carbon has a large sorption capacity for many water impurities, including synthetic organic chemicals, taste- and odor-causing compounds, and some species of mercury.

Adsorption capacity is typically represented by the Freundlich isotherm constant, with higher Freundlich (K) values indicating greater sorption potential. Activated carbon is considered to be cost-effective for removing a particular contaminant if the Freundlich (K) value of the contaminant is above 200 µg/g (L/µg)^{1/n} (Speth *et al.*, 2001). The Freundlich (K) value for EPTC is approximately 79,500 µg/g (L/µg)^{1/n}, which indicates that GAC is a promising treatment option (Speth *et al.*, 2001).

Reverse osmosis (RO) is similar to other membrane processes, such as ultrafiltration and nanofiltration, in that water passes through a semi-permeable membrane. However, in the case of RO, the membrane is non-porous. RO involves the use of applied hydraulic pressure to oppose the osmotic pressure across the membrane, forcing the water from the concentrated-solution side to the dilute-solution side. The water dissolves into the membrane, diffuses across, then dissolves out into the permeate. Most inorganic and many organic contaminants are rejected by the membrane and will be retained in the concentrate.

USEPA (2000) reports that the carbamate class of pesticides can be removed with 85.7 percent efficiency using a cellulose acetate membrane, 79.6 to 93 percent efficiency using a polyamide membrane, and greater than 92.9 percent efficiency using a thin-film composite membrane. These results indicate that RO is a promising option for removal of EPTC in drinking water.

8.5 Regulatory Determination

The Agency has made a determination not to regulate EPTC with a national primary drinking water regulation (NPDWR). Because EPTC does not appear to occur at health levels of concern in PWSs, the Agency believes that an NPDWR does not present a meaningful opportunity for health risk reduction. While EPTC has been found in ambient waters at levels less than the HRL of 175 µg (as well as ½ the HRL), it was not found in the UCMR 1 survey of public water supplies.

The Agency's regulatory determination for this contaminant is presented formally in the *Federal Register*.

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