UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OCT 25 1993

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

OSWER Directive 9360.1-02

MEMORANDUM

SUBJECT: Final Guidance on Numeric Removal Action Levels for Contaminated Drinking Water Sites

FROM: Deborah Y. Dietrich, Director
Emergency Response Division

Deborah Y. Dietrich

TO: Removal Managers
Regions I - X

Purpose

The purpose of this memorandum is to transmit the final OERR methodology and guidance on the calculation of numeric removal action levels (RALs), to assist Superfund personnel in deciding whether to provide alternate sources of drinking water to populations adversely affected by releases of hazardous substances into the environment.

Introduction

RALs are drinking water concentrations of contaminants that are considered, along with other factors, in determining whether to provide alternate water supplies under Superfund removal authority. RALs were established in OSWER (Office of Solid Waste and Emergency Response) Directive 9360.1-01, Interim Final Guidance on Removal Action Levels at Contaminated Drinkina Water Sites (October 1987). That directive defined two types of RALs: (1) numeric levels for individual substances, which apply generally across most sites, and (2) site-specific levels, which are based on a more detailed analysis of conditions at a particular site and are determined on a case-by-case basis. A methodology for calculating numeric RALs for drinking water was presented in the 1987 OSWER directive, and values for 34 substances were listed in Exhibit 2 of that directive. The Office of Emergency and Remedial Response (OERR)/Emergency Response Division (ERD) distributed an updated and significantly expanded table of numeric RALs in April 1991 that listed values - calculated using the same methodology described in the 1987 OSWER Directive - for 165 substances.

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Objective

ERD has adopted a new methodology for determining RALs for contaminated drinking water. This memorandum explains the new methodology and provides the rationale for adopting it. As discussed in the next section, the new methodology better matches the needs of the Superfund removal program and is more consistent with procedures used by the Office of Water (OW) than the previous guidance. The attached table lists updated numeric RALs for 204 substances developed using the new methodology. These updated RALs supersede the values given in the April 1991 table distributed by ERD. Regions should begin using the newly updated RALs immediately, in the same manner as previous values were used (i.e., as one factor in deciding whether to provide alternate water supplies under Superfund removal authority). Issuance of this update of numeric RALs does not in any way restrict the existing flexibility of a Regional office to develop and apply site-specific RALs. Note that the updated numeric RALs apply to new removal starts, and, in general, are not intended to affect ongoing or completed removal actions.

Implementation

New RAL Methodology: Background and Rationale

ERD has adopted the procedures recently developed by OW for determining short-term acceptable risk (STAR) levels as the new methodology for setting numeric RALs for drinking water. The STAR is one factor, along with cost and affordability considerations, used in making unreasonable risk to health (URTH) determinations under the Safe Drinking Water Act. Under the Act, EPA (or primacy states) may grant a public water system a variance or exemption from a Maximum Contaminant Level (MCL; for definition, see box on page 5) if it finds that the variance or exemption will not result in an URTH.

The STAR is defined as the upper-bound concentration of a contaminant in drinking water, generally above the MCL (and never lower than the MCL), that would not pose a health risk for exposures lasting up to seven years (approximately 10 percent of an individual's lifetime). As of the date of this memorandum, OW has released STAR values for 47 chemical substances, all of which are included in the attached table of updated RALs. In addition, OW has issued Guidance for Determining Unreasonable Risks to Health (EPA/OW/Office of Science and Technology, 1992), which describes in detail the procedures for determining STARs. The guidance also allows for development of site-specific URTHs, where appropriate, and lists factors to be considered in their development.

ERD adopted the STAR methodology to replace its previous approach to determining RALs for drinking water primarily for the following reasons:

- As risk-based levels developed specifically for relatively short-term exposures to individual contaminants in drinking water, STARs are the Agency numbers that most closely correspond to the needs of the Superfund removal program for action levels. Levels based on exposure periods of up to seven years are more relevant to removal program decision-making than levels based on lifetime exposures (as used in the previous approach). It is important to note, however, that while the STAR is a level for short-term exposure, it is derived from numbers (e.g., MCLs and drinking water equivalent levels (DWELs)) that are protective over a lifetime of exposure.

- STARs are developed using OW procedures and data, which are extensively reviewed both within the Agency and by independent scientific groups, including EPA's Science Advisory Board and the National Academy of Sciences. In addition, the STAR methodology was subject to public review and comment as part of its development process.

- Problems that potentially could arise from inconsistencies between RALs and STARs will be avoided, as EPA will be using the same approach to evaluating short-term exposures to drinking water contamination in the Superfund removal program as in the OW drinking water program.

Thus, the new methodology enhances both the scientific credibility of RALs and their consistency with OW procedures and data.

Differences Between the Old and New Methodologies

There are several differences between the newly adopted methodology and the previous approach to determining RALs, including: (1) primary reliance on OW data and procedures; (2) explicit consideration of short-term toxicity data; (3) elimination of the possibility of a numeric RAL being lower than the corresponding MCL; and (4) elimination of the two-fold reduction factor applied to volatile non-carcinogens. The previously used adjustment factor for volatiles was eliminated because the OW values and calculation procedures that are the basis of the new methodology are considered protective of exposures from inhalation of volatiles released from drinking water as well as from direct ingestion.

It is important to note that exposure to volatiles other than through ingestion is receiving much Agency attention. The

Office of Water is investigating methodologies for assessing inhalation risks from volatile contaminants (mainly trihalomethanes) and is scheduled to take action on this issue this year. What the Office of Water does with trihalomethanes will have important implications for other volatiles and may lead to some modifications of the assumptions and methodologies used to derive STAR levels and other drinking water standards. Currently, the Office of Water considers the RfD/DWEL, longer-term health advisory, and cancer risk level protective for volatile and non-volatile contaminants because exposure from sources other than drinking water are not factored out of the risk calculations as they are for the MCL/MCLG. This approach continues to have the approval of the NAS and SAB. Please keep in mind that regional personnel may always choose to factor in inhalation exposure as they would any other site-specific consideration when deciding to perform a removal action.

In addition, OW's lo-day Health Advisory values are no longer considered in the RAL process. Although never part of the actual calculation procedure for numeric RALs, 10-day Health Advisories were listed in the October 1987 and April 1991 tables of values, and the October 1987 directive instructed that they be considered in certain "special cases" (including the case referred to above, which no longer occurs, when a calculated numeric RAL was lower than the corresponding MCL). Because 10-day Health Advisories are developed for much shorter exposure periods (i.e., 10 days) than is appropriate for many removal site situations, where exposure to contaminated drinking water may have occurred over weeks, months, or even years, they are not considered adequately protective, in general, for application at removal sites. Moveover, at many sites there is substantial uncertainty over exactly how long exposures have been occurring. Therefore, the newly updated RALs, which are based on a more relevant exposure period, should be used rather than 10-day Health Advisories, except possibly in the (presumably rare) situation where it can be documented that exposure is extremely short-term and will not exceed approximately 10 days in duration.

Overview of OW's STAR Methodology

Several toxicity- or risk-based levels developed by OW are considered in developing STARs. These levels are defined in the box on the next page. The STAR methodology is described in detail in OW's referenced 1992 URTH guidance.

MCLG (maximum contaminant level goal): A non-regulatory health goal based solely on considerations of protecting the public from adverse health effects of drinking water contamination.

MCL (maximum contaminant level): A regulatory level that sets the maximum permissible concentration of a contaminant in water delivered to users of public water systems. The MCL is set as close to the MCLG as feasible, considering such factors as analytical capability, treatment availability, and treatment costs.

DWEL (drinkins water equivalent level): The concentration of a contaminant in drinking water that is not expected to cause any adverse non-cancer health effects in humans over a lifetime of continuous exposure. The DWEL, in mg/l, is calculated by multiplying the oral reference dose (RfD), in mg/kg-day, by 70 kg (standard adult body weight) and dividing it by 2 liters/day (standard adult water consumption rate).

Longer-term HA (health advisory) (child): The concentration of a contaminant in drinking water that is not expected to cause any adverse non-cancer health effects in children over a continuous exposure period of up to seven years. The Longer-term HA is calculated similarly to the DWEL, but instead of the RfD, a no- or lowest-observed-adverse-effect-level (NOAEL or LOAEL) from a study in which the exposure duration is comparable to seven years of human exposure is used. The NOAEL or LOAEL, in mg/kg-day, is divided by appropriate uncertainty factors, then multiplied by 10 kg (standard child body weight) and divided by 1 l./day (standard child water consumption rate).

10^{-4} cancer risk level: The concentration of a contaminant in drinking water that would result in a 10^{-4} upper-bound lifetime excess cancer risk to an individual exposed continuously over a lifetime (other pre-specified risks, such as 10^{-5}, also can be defined). The cancer risk level is calculated based on the pre-specified risk, the contaminant's cancer slope. factor, the standard adult body weight of 70 kg, and the standard adult water consumption rate of 2 l/day.

The level that ultimately becomes the basis for a STAR depends in part on the type of effects caused by the substance. Of particular importance in the STAR methodology is a substance's potential for human carcinogenicity, as reflected in EPA's cancer weight-of-evidence classification. EPA's classification system

(described in detail in Guidelines for Carcinogen Risk Assessment, 51 Federal Resister 33992, September 24, 1986) defines the following major categories:

A Human carcinogen
B Probable human carcinogen
C Possible human carcinogen
D Not classifiable as to human carcinogenicity
E Evidence of non-carcinogenicity

For Group A or B carcinogens, the STAR is set at the MCL whenever the MCL is greater than or equal to the 10^{-4} cancer risk level. When the MCL is less than the 10^{-4} cancer risk level, the STAR is the lowest value among the 10^{-4} cancer risk level, the DWEL, or the Longer-term HA (child). As examples of these two cases, consider ethylene dibromide and benzene.

- The STAR for ethylene dibromide is set at the MCL, 0.05 µg/l, because the MCL is greater than the 10^{-4} cancer risk level, 0.04 µg/l.

- Conversely, the STAR for benzene is set at the 10^{-4} cancer risk level, 100 µg/l, because the MCL of 5 µg/l is less than the 10^{-4} cancer risk level (no DWEL or Longer-term HA (child) available).

For Group D, E, or unrated substances (i.e., substances considered to be non-carcinogens for purposes of this methodology), the STAR is set at the MCL whenever a contaminant's main health effects are very short-term and the MCL is based on effects of acute exposures. Otherwise, the STAR is the lower of the DWEL or Longer-term HA (child) values. For example, the DWEL for methoxychlor is 200 µg/l, the Longer-term HA (child) is 50 µg/l, and the MCL is not based on very short-term effects. Therefore, the STAR is set at 50 µg/l.

For Group C carcinogens, which have limited evidence for human carcinogenicity, the STAR is usually based on non-cancer effects and is the lowest value among the DWEL, the Longer-term HA (child), or the MCLG multiplied by 10. The lo-fold adjustment of the MCLG removes the additional safety factor included in the MCLG for Group C carcinogens to protect against possible cancers resulting from lifetime exposure, a factor not considered necessary for developing a STAR. As an example, consider atrazine, which has a DWEL of 200 µg/l, a Longer-term HA (child) of 60 µg/l, and an "MCLG times 10" value of 30 µg/l (MCLG equals 3 µg/l). Therefore, the STAR is set at the lowest of these three values, or 30 µg/l.

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[1] If toxicity information is inadequate to develop a DWEL or Longer-term HA (child), the MCLG (and therefore the STAR) can be based on a cancer risk level.

Development of Numeric RALs Using the STAR Methodology

If a STAR value is available from OW, it is used without adjustment as the numeric RAL. If ow has evaluated a substance but has not developed a STAR, the numeric RAL is determined using the STAR methodology and input data from OW. When an OW evaluation is unavailable for a substance, a few modifications to the STAR methodology are necessary because some of the needed input values may not be available.

For substances lacking an ow evaluation, RALs are based on a subset of the STAR procedures. MCLs, MCLGs, and Longer-term HAs (child) are unavailable in these situations and are not considered: DWELs and cancer risk levels are calculated based on toxicity information (oral RfDs, oral cancer weight-of-evidence ratings, and oral cancer slope factors) from other Agency data sources and then used to determine the RAL. EPA's on-line Integrated Risk Information System (IRIS) should be the first source consulted for this toxicity information (assuming no information is available directly from OW), followed by EPA's Health Effects Assessment Summary Tables (HEAST) (Office of Research and Development, March 1992 or most recent update).

Exhibit 1 is a matrix summarizing the new numeric RAL methodology for both situations - when an OW evaluation is available for a substance and when an OW evaluation is unavailable. Exhibits 2A (OW evaluation available) and 2B (OW evaluation unavailable) are a parallel set of flowcharts depicting the RAL determination process.

Site-specific RALs

A significant health threat may exist at a site even if no substance is currently present in drinking water at a concentration exceeding its numeric RAL. A removal action may be initiated if the health risk at a site has been analyzed in detail and the analysis indicates that a serious risk is present due to site-specific factors. Examples of such factors include evidence that a ground-water plume with contamination exceeding a RAL is moving toward drinking water wells, current contaminant levels will likely increase (e.g., due to increased pumping from an aquifer anticipated during summer months), people 'have been drinking contaminated water for a long period of time already, multiple contaminants are likely to result in additive or synergistic effects, or sensitive populations are present and being exposed to the contamination. OW's URTH guidance, adopted as the new basis for numeric RALs, provides for similar site-specific flexibility to depart from recommended STAR levels based on considerations such as site-specific exposures, exposures from other sources, past exposure (if known), exposure to mixtures of drinking water contaminants, population sensitivity, chemical characteristics such as volatility, or other factors not directly related to the contaminant.

Decisions to undertake a removal action when a numeric RAL has not been exceeded should be made on a case-by-case basis. Because ERD wishes to know how guidance is used in the Regions, please notify your Regional Coordinator of any Action Memo approved for contaminated drinking water sites where the removal action decision is based solely on site-specific factors (i.e., no numeric RAL is exceeded).

Information Sources

The attached table of numeric RALs for drinking water, dated November 1992, lists values for many substances of concern at drinking water contamination sites. ERD plans to distribute updates to the table, as appropriate, such as when OW releases a significant number of new or revised STARs. In the meantime, Regional offices should use the most up-to-date STAR available for a substance as the numeric RAL. If OW has released a revised STAR that differs from the value given in the attached table, Regional offices should use that revised STAR as the numeric RAL. Information on STARs and other OW data used in the new RAL methodology is available through the Safe Drinking Water Hotline at 800-426-4791.

If a substance of concern is not listed in the attached table, Regional offices may determine the appropriate numeric RAL by applying the methodology summarized in this memorandum (refer to the OW URTH guidance for a more detailed description of the STAR procedures). Alternatively, a Regional office may request ERD's assistance in determining the appropriate numeric RAL. If a Region decides to develop a numeric RAL itself, it must first check with OW to determine if a-STAR is available and, if not, whether OW has developed any of the other risk-based levels needed as inputs (e.g., MCL/MCLG, DWEL, Longer-term HA (child), 10^{-4} cancer risk level). If there is no information available from OW, the Regional office may calculate and use DWELs and cancer risk levels to develop numeric RALs, based on toxicity information in IRIS or HEAST. For additional'information on IRIS, contact user support in the Office of Research and Development, Cincinnati, OH, at 513-569-7254. For additional information on HEAST, contact the Superfund Health Risk Technical Support Center in the Office of Research and Development, Cincinnati, OH, at 513-569-7300.

Substances With Significant Changes in Numeric RALs

Exhibit 3 lists those substances for whioh the RAL has changed significantly (defined as more than a factor of two) from the value in the table distributed by ERD in April 1991.

Please distribute this update to all removal program staff in your Regional office. If you have any questions on this document, contact Lisa Boynton (OERR/ERD), at 703-603-9052.

EXHIBIT 1
SUMMARY OF NEW METHODOLOGY FOR NUMERIC RALs

Cancer Weight-of-evidence Class	OW Evaluation of Substance Available[1]	OW Evaluation of Substance Unavailable[2]
A or B	•If MCL $\geq 10^{-4}$ cancer risk level: RAL = MCL •If MCL $< 10^{-4}$ cancer risk level: RAL = lowest of: 10^{-4} cancer risk level, or DWEL, or Longer-term HA (child)	•RAL = lower of: 10^{-4} cancer risk level, or DWEL
C	•RAL = lowest of: MCLG x 10, or DWEL, or Longer-term HA (child)	•If DWEL can be calculated: RAL = DWEL x 0.2 (20% relative source contribution assumed) •If DWEL cannot be calculated: RAL = 10^{-4} cancer risk level
D, E, or unrated	•If MCL based on acute toxicity: RAL = MCL •If MCL not based on acute toxicity: RAL = lower of: DWEL, or Longer-term HA (child)	•RAL = DWEL

[1] Use OW values for HCL, MCLG, DUEL, Longer-term HA (child), and 10^{-4} cancer risk level.

[2] Obtain oral RfD, oral cancer weight-of-evidence rating, and oral cancer slope factor from IRIS (or HEAST if unavailable in IRIS), then calculate DWEL and 10^{-4} cancer risk level.

EXHIBIT 2A
DECISION FLOW DIAGRAM FOR RAL METHODOLOGY:
OFFICE OF WATER EVALUATION AVAILABLE

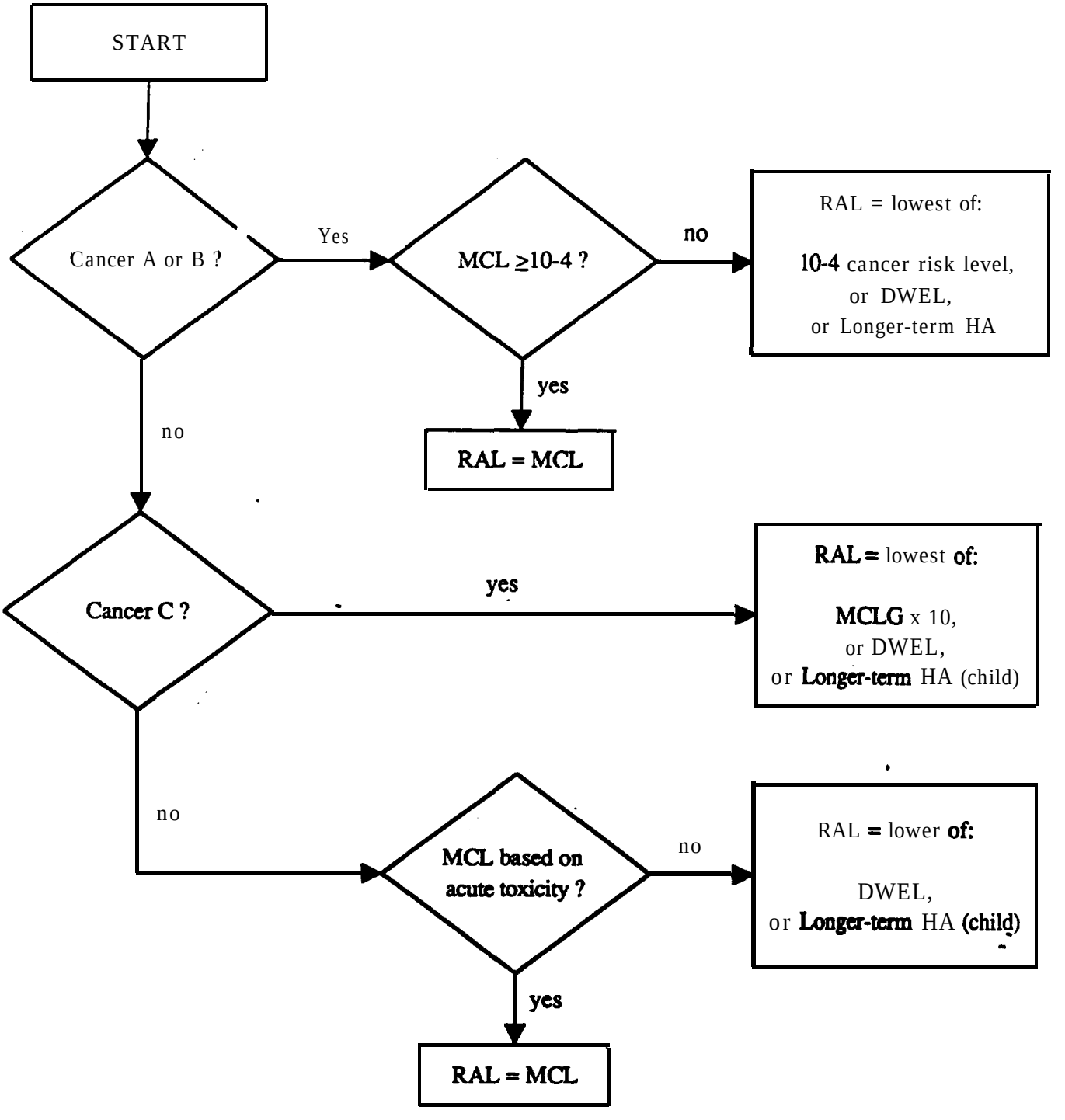

EXHIBIT 2B
DECISION FLOW DIAGRAM FOR RAL METHODOLOGY:
OFFICE OF WATER EVALUATION NOT AVAILABLE

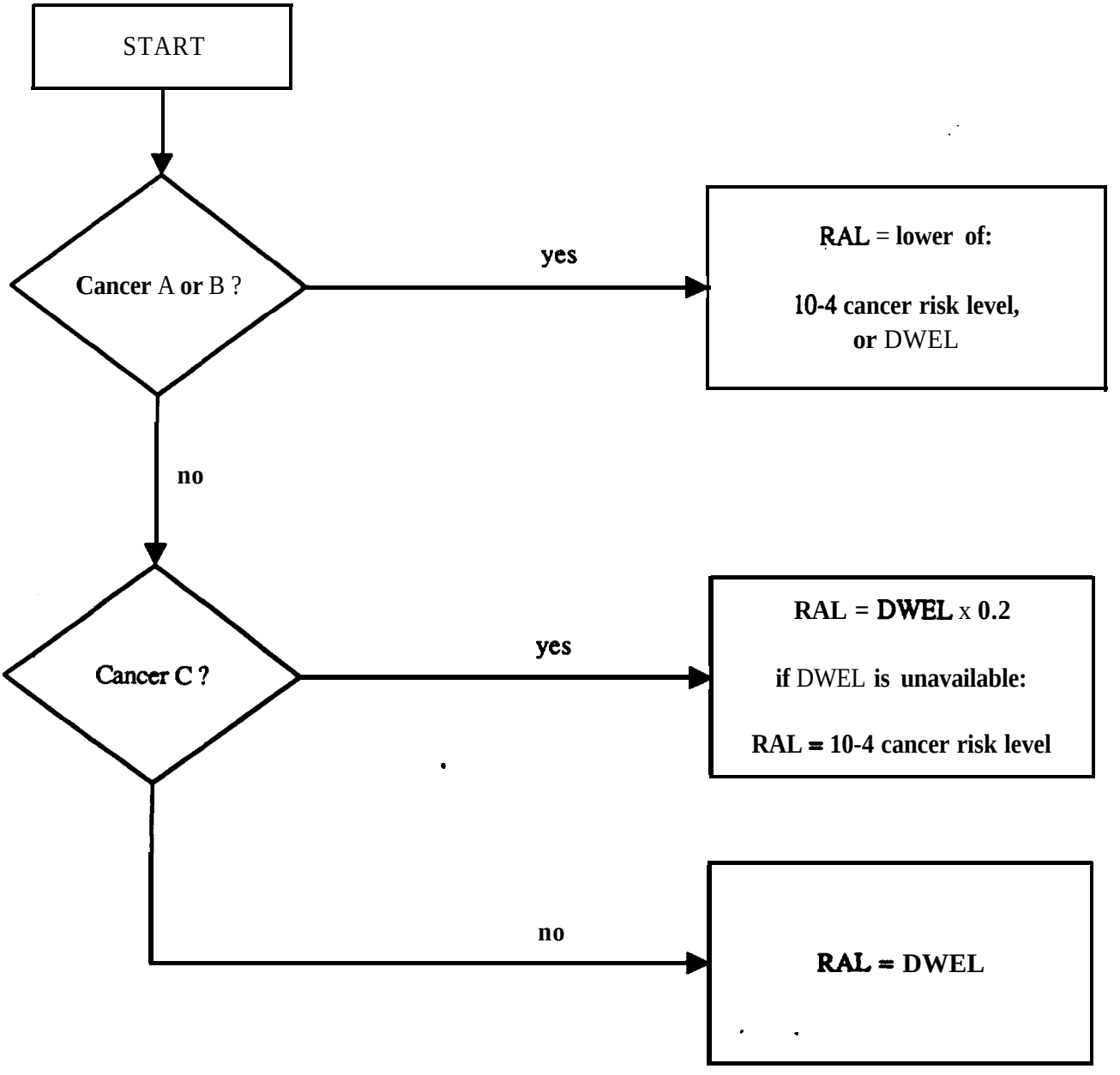

EXHIBIT 3
SUBSTANCES FOR WHICH NUMERIC RALs HAVE CHANGED SIGNIFICANTLY

Substance	1991 (Old) RAL (µg/l)	New RAL (µg/l)	Factor Increase/ Decrease
ORGANICS			
Acifluorfen (Tackle)	460	100	-4.6
Acrylonitrile	6.5	1	-6.5
Aldicarb (Temik)	2.5	7	+2.8
Atrazine	180	30	-6.0
Baygon	140	40	-3.5
Bromodichloromethane	27	60	+2.2
Bromomethane	25	50	+2.0
Carbaryl	3,500	1,000	-3.5
Carbofuran	180	50	-3.6
Carbon tetrachloride	12	30	+2.5
Carboxin	3,500	1,000	-3.5
Chloramben	530	200	-2.7
Chlorodibromomethane	42	700	+17
Chloromethane	270	100	-2.7
Chlorophenol (2-)	180	50	-3.6
Chlorothalonil	530	150	-3.5
Chlorotoluene (o-)	350	700	+2.0
Chlorpyrifos	110	30	-3.7
Cyanazine	70	20	-3.5
2,4-D (2,4-Dichloro-phenoxyacetic acid)	350	100	-3.5
Dacthal (DCPA)	18,000	5,000	-3.6
Dalapon	1,100	300	-3.6
Diazinon	32	3	-11
Dicamba	46	300	+6.5
Dichlorobenzene (1,4-)	150	750	+5.0
Dichloroethylene (1,1-)	5.8	70	+12
Dichlorophenol (2,4-)	110	30	-3.7
Dimethyl phthalate	35,000	350,000	+10
Dinoseb	35	10	-3.5

EXHIBIT 3 (continued)
SUBSTANCES FOR WHICH NUMERIC RALs HAVE CHANGED SIGNIFICANTLY

Substance	1991 (Old) RAL (µg/l)	New RAL (µg/l)	Factor Increase/ Decrease
Dioxane (1,4-)	320	700	+2.2
Diphenamid	1,100	300	-3.7
Endothall	700	200	-3.5
Endrin	11	3	-3.7
Ethylene glycol	70,000	6,000	-12
Fonofos	70	20	-3.5
Glyphosate	3,500	1,000	-3.5
Hexane (n-)	21,000	4,000	-5.3
Isophorone	850	7,000	+8.3
Isopropylbenzene (Cumene)	1,400	14,000	+10
Malathion	700	200	-3.5
Maleic hydrazide	18,000	5,000	-3.6
MCPA ((4-Chloro-2-methylphenoxy)-acetic acid)	18	50	+2.8
Methomyl	880	300	-2.9
Methoxychlor	180	50	-3.6
Metolachlor	5,300	2,000	-2.7
Metribuzin	880	300	-2.9
Oxamyl (Vydate)	880	200	-4.4
Paraquat	160	50	-3.2
Pentachloronitrobenzene	14	100	+7.2
Phenol	21,000	6,000	-3.5
Picloram	2,500	700	-3.6
Prometon	530	200	-2.7
Pronamide (Kerb)	2,600	800	-3.3
Propachlor	460	100	-4.6
RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine)	32	100	+3.2
Styrene	3,500	1,000	-3.5
TCDD (2,3,7,8-) (Dioxin)	22 pcg/l	50 pcg/l	+2.3
Tebuthiuron	2,500	700	-3.6
Terbufos	3.5	1	-3.5

EXHIBIT 3 (continued)
SUBSTANCES FOR WHICH NUMERIC RALs HAVE CHANGED SIGNIFICANTLY

Substance	1991 (Old) RAL (µg/1)	New RAL (µg/1)	Factor Increase4 Decrease
Tetrachloroethane (1,1,1,2-)	130	900	+6.9
Tetrachloroethane (1,1,2,2-)	18	2	-9.0
2,4,5-TP (2(2,4,5-Trichlorophenoxy)propionic acid)	280	70	-4.0
Trichlorobenzene (1,2,4-)	46	100	+2.2
Trichloroethane (1,1,2-)	61	30	-2.1
Trifluralin	260	80	-3.3
INORGANICS			
Arsenic	2	50	+25
Barium	1,800	5,000	+2.8
Boron	3,200	900	-3.6
Cadmium	18	5	-3.6
Cyanide	700	200	-3.5
Fluoride	2,100	5,000	+2.4
Maganese	3,500	200	-17
Molybdenum	140	10	-14
Nitrite	3,500	1,000	-3.5
Vanadium	250	30	-8.3
Zinc	7,000	3,000	-2.3

[1] The ratio between the new RAL and the old RAL. A "+" indicates that the RAL has increased, while a "-" indicates that the RAL has decreased.

NUMERIC REMOVAL ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES

Tables

Emergency Response Division
Office of Solid Waste and Emergency Response
U.S. Environmental Protection Agency
Washington, DC 20460

May 1993

Table Acronyms

CAS #	Chemical Abstract Number
DWEL	Drinking Water Equivalent Level (calculated by multiplying the oral RfD by 70 kilograms (adult body weight) and dividing by the average volume of water (2 liters) consumed per day)
Longer-term HA (Child)	Drinking Water Health Advisory for 10 kg child consuming 1 liter water per day for up to 7 years
MCL	Maximum Contaminant Level (National Primary Drinking Water Standard)
MCLG	Maximum Contaminant Level Goal
MFL	Million fibers per Liter
Treat. Tech.	MU is based on the capability of the treatment technology
URTH-STAR	Draft Short-term Risk Level (STAR) recommended for an Unreasonable Risk to Health (URTH) under Safe Drinking Water Act

NUMERIC REMOVAL ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
PRIMARY DRINKING WATER STANDARDS AND HEALTH ADVISORIES
May 1993

Chemical		Cancer Risk		Standards and Health Advisories				Superfund
ORGANICS	CAS #	Cancer Group	10^{-4} Cancer Risk (µg/L)	DWEL (µg/L)	Longer-term HA (Child) (µg/L)	MCL / MCLG (µg/L)	URTH -STAR- Level (µg/L)	Removal Action Level (µg/L)
Acenaphthene	83329	—	—	2,100	—	—	—	2,100
Acetone	67641	D	—	3,500[a]	—	—	—	3,500
Acifluorfen (Tackle)	62476599	B 2	100	400	100	— / 0	—	100
Acrylamide (2-Propenamide)	79061	B2	1	7	20	Treat. Tech. / 0	1	1
Acrylonitrile	107131	B1	6	—	—	— / 0	—	6
Adipates (Diethylhexyl)	103231	C	—	20,000	—	500 / 500	—	5,000
Alachlor	15972608	B2	40	400	—	2 / 0	40	40
Aldicarb (Temik)	116063	D	—	35	—	311		3 5
Aldicarb sulfone	1646884	D	—	35'	—	2 / 1	—	35
Aldicarb sulfoxide	—	D	—	35	—	4 / 1		3 5
Aldrin	309002	B2	0.2	1	0.3	—	—	0.2
Ametyrn	834128	D	—	300	900	—	—	300
Ammonium sulfamate	7773060	D	—	8,000	20,000	—	—	8,000
Anthracene	120127	D	—	11,000	—	—	—	11,000
Atrazine	1912249	c	—	200	60	3 / 3	30	30
Baygon	114261	c	—	100	40	—	—	40
Bentazon	25057890	D	—	90	300	— / 20	—	90
Benz(a)anthracene	56553	B2	—	—	—	0.1 / 0	—	0.1
Benzene	71432	A	100	—	—	5 / 0	100	100
Benzo(a)pyrene	50328	B2	—	—	—	0.2 / 0	—	0.2
Benzo(b)fluoranthene	205992	B2	—	—	—	0.2 / 0	—	0.2
Benzo(k)fluoranthene	207089	B2	—	—	—	0.2 / 0	—	0.2
bis-2-Chloroisopropyl ether	108601	D	—	1,000	4,000	—	—	1,000
Bromacil	314409	C	—	5,000	3,000	—	—	3,000
Bromochloromethane	74975	D[a]	—	500	1,000	—	—	500
Bromodichloromethane	75274	B2	60	700	4,000	100 / 0	—	60
Bromoform	75252	B2	400	700	2,000	100 / 0	—	400

NUMERIC REMOVAL ACTION LEVELS FOR CONTAMINATED DRINKING WATER SITES
PRIMARY DRINKING WATER STANDARDS AND HEALTH ADVISORIES
May 1993

Chemical ORGANICS	CAS #	Cancer Risk: Cancer Group	Cancer Risk: 10^{-4} Cancer Risk (µg/L)	Standards and Health Advisories: DWEL (µg/L)	Longer-term HA (Child) (µg/L)	MCL / MCLG (µg/L)	URTH -STAR- Level (µg/L)	Superfund Removal Action Level (µg/L)
Bromomethane (Methyl bromide)	74839	D	—	40	100	—	—	40
Butanone (2-) (see Methyl ethyl ketone)								
Butyl benzyl phthalate	85687	C	—	woo	—	100 / 0		6,000
Butylate	2008415	D	—	2,000	1,000	—	—	1,000
Carbaryl	63252	D	—	4,000	1,000	—	—	1,000
Carbofuran	1563662	E	—	200	50	40 / 40	50	50
Carbon tetrachloride	56235	B2	30	30	70	5 / 0	30	30
Carboxin	5234684	D	—	4,000	1,000	—	—	1,000
Chloral hydrate (Trichloroacetaldehyde monohydrate)	302170	C	—	70	200	— / 60	—	70
Chloramben	133904	D	—	500	200	—	—	200
Chlordane	57749	B2	3	2	—	2 / 0	2	2
Chlorobenzene (see Monochlorobenzene)								
Chlorodibromomethane (Dibromochloromethane)	124481	C	—	700	2,000	100 / 0	—	700
Chloroform (Trichloromethane)	67663	B2	600	400	100	loo/O	—	100
Chloromethane (Methyl chloride)	74873	C	—	100	400	—	—	100
Chlorophenol (2-)	95578	D	—	200	50	—	—	50
Chlorothalonil	1897456	B2	150	500	200	—		150
Chlorotoluene, o-	95498	D	—	700	2,000	—	—	700
Chlorotoluene, p-	106434	D	—	700	2,000	—	—	700
Chlorpyrifos	2921882	D	—	100	30	—	—	30
Chrysene	218019	B2	—	—	—	0.2 / 0	—	0.2
Cumene (see Isopropylbenzene)								
Cyanazine	21725462	C	—	70	20	-#i	—	20
2.4-D (2,4-Dichlorophenoxyacetic acid)	94757	D	—	400	100	70 / 70	100	100
Dacthal (DCPA)	1861321	D		20,000	5,000	—	—	5,000
Dalapon	75990	D	—	900	300	200 / 200	—	300

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ORGANICS	CAS #	Cancer Group	10^{-4} Cancer Risk (µg/L)	DWEL (µg/L)	Longer-term HA (Child) (µg/L)	MCL / MCLG (µg/L)	URTH -STAR- Level (µg/L)	Removal Action Level (µg/L)
Di[2-ethylhexyl]adipate	103231	C	3,000	20,000	20,000	400 / 400	—	4,000
Diazinon	333415	E	—	3	5	—	—	3
Dibenzo[a,h]anthracene	53703	B2	—	—	—	0.3 / 0	—	0.3
Dibromoacetonitrile	3252435	c	—	800	2,000	—	—	800
Dibromochloromethane (see Chlorodibromomethane)								
Dibromochloropropane (DBCP)	96128	B2	3	—	—	0.2 / 0	3	3
Dibromomethane (Methylene Bromide)	74953	D	—	—	—		—	—
Dibutyl phthalate (Di-n-butyl phthalate)	84742	D	—	4,000	—	—	—	4,000
Dicamba	1918009	D	—	1,000	300	—	—	300
Dichloroacetic acid	79436	B2	—	300	5,000	— / 0	—	300
Dichloroacetonitrile	3018120	C	—	300	800		—	300
Dichlorobenzene -o (1,2-)	95501	D	—	3,000	9,000	600 / 600	3,000	3,000
Dichlorobenzene -m (1,3-)	541731	D	—	3,000	9,000	600 / 600	—	3,000
Dichlorobenzene -p (1,4-)	106467	c	—	4,000	10,000	75 / 75	750	750
Dichlorodifluoromethane (Freon-12)	75718	D	—	5,000	9,000	—	—	5,000
Dichloroethane (1,1-)	75343	C[a]	—	3,500[a]	—	—	—	3,500
Dichloroethane (1,2-) (Ethylene dichloride)	107062	B2	40	—	700	5 / 0	40	40
Dichloroethylene (1,1-)	75354	C	—	400	1,000	7 / 7	70	70
Dichloroethylene (cis- 1,2-)	156592	D	—	400	3,000	70 / 70	400	400
Dichloroethylene (trans- 1,2-)	156605	D	—	600	2,000	100 / 100	600	600
Dichloromethane (Methylene chloride)	75092	B2	500	2,000	—	5 / 0	—	500
Dichlorophenol (2,4-)	120832	D	—	100	30	—	—	30
Dichloropropane (1,2-)	78875	B2	—	—	—	5 / 0	—	5
Dichloropropene (1,3-) (cis and trans)	542756	B2	20	10	30	— / 0	—	10
Dieldrin	60571	B2	0.2	2	0.5	—	—	0.2
Diettlyl phthalate	84662	D	—	30,000	—	—	—	30,000
Diethylhexyl (see Adipates)								

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Diethylhexyl phthalate	117817	B2	300	700	—	6 / 0	—	300
Dimethrin	70382	D	—	10,000	10,000	—	—	10,000
Dimethyl methylphosphonate	756796	C	700	7,000	2,000	—	—	2,000
Dimethyl phthalate	131113	D	—	350,000[a]	—	—	—	350,000
DIMP (Diisopropylmethylphosphonate)	1445756	D	—	3,000	8,000	—	—	3,000
Dinitrobenzene (1,3-)	99650	D	—	5	40	—	—	5
Dinitrotoluene (2,4-)	121142	—	—	100	300	—	—	—
Dinitrotoluene (2,6-)	25321146	—	—	40	400	—	—	—
Dinitrotoluene, tg[b] (2,6- & 2,4-)	—	B2	5	—	—	—	—	5
Dinoseb	88857	D	—	40	10	7 / 7	—	10
Dioxane p- (1,4-)	123911	B2	700	—	—	—	—	700
Dioxin (see 2,3,7,8-TCDD)								
Diphenamid	957517	D	—	1,000	300	—	—	300
Diphenylamine	122394	D	—	1,000	300	—	—	300
Diquat	85007	D	—	80	—	20 / 20	—	80
Disulfoton	298044	E	—	1	3	—	—	1
Dithiane (1,4-)	505293	D	—	400	400	—	—	400
Diuron	330541	D	—	70	300	—	—	70
Endothall	145733	D	—	700	200	100 / 100	—	200
Endrin	72208	D	—	10	3	2 / 2	—	3
Epichlorohydrin	106898	B2	400	70	70	Treat. Tech. / 0	70	70
Ethylbenzene	100414	D	—	3,000	1,000	700 / 700	1,000	1,000
Ethylene dibromide (1,2-) (EDB)	106934	B2	0.04	—	—	0.05 / 0	0.05	0.05
Ethylene dichloride (see 1,2-Dichloroethane)								
Ethylene glycol	107211	D	—	40,000	6,000	—	—	6,000
Ethyl ether	60297	—	—	7,000[a]	—	—	—	7,000
Ethylene thiourea (ETU)	96457	B2	30	3	100	—	—	3

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ORGANICS	CAS #	Cancer Group	10^{-4} Cancer Risk (µg/L)	DWEL (µg/L)	Longer-term HA (Child) (µg/L)	MCL / MCLG (µg/L)	URTH -STAR- Level (µg/L)	Removal Action Level (µg/L)
Fenamiphos	22224926	D	—	9	5	—	—	5
Fluometuron	2164172	D	—	400	2,000	—	—	400
Fluorene	86737	D	—	1,400	—	—	—	1,400
Fluorotrichloromethane (Freon-11)	75694	D	—	10,000	3,000	—	—	3,000
Fonofos	944229	D	—	70	20	—	—	20
Formaldehyde	50000	B1	—	5,000	5,000	—	—	5,000
Freon-11 (see Fluorotrichloromethane)								
Freon-12 (see Dichlorodifluoromethane)								
Freon 113 (1,1,2-Trichloro-1,2,3-trifluoroethane)	76131	—	—	1,100,000[a]	—	—	—	1,100,000
Glyphosate	1071836	D	—	4,000	1,000	700 / 700	—	1,000
Heptachlor	76448	B2	0.8	20	5	0.4 / 0	0.8	0.8
Heptachlor epoxide	1024573	B2	0.4	0.4	0.1	0.2 / 0	0.4[c]	0.4
Hexachlorobenzene	118741	B2	2	30	50	1 / 0	—	2
Hexachlorobutadiene	87683	C	—	70	100	— / 1	—	70
Hexachlorocyclohexane, gamma (see Lindane)								
Hexachlorocyclopentadiene	77474	D	—	200	—	50 / 50	—	200
Hexachloroethane	67721	C	—	40	100	—	—	40
Hexane (n-)	110543	D	—	—	4,000	—	—	4,000
Hexazinone	51235042	D	—	1,000	3,000	—	—	1,000
HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)	2691410	D	—	2,000	5,000	—	—	2,000
Indeno[1,2,3-c,d]pyrene	193395	B2	—	—	—	0.4 / 0	—	0.4
Isophorone	78591	C	4,000	7,000	15,000	—	—	7,000
Isopropyl methylphosphonate	6838933	D	—	4,000	30,000	—	—	4,000
Isopropylbenzene (Cumene)	88828	—	—	1,400[a]	—	—	—	1,400
Kerb (see Pronamide)								
Lindane (Hexachlorocyclohexane, gamma)	58899	C	—	10	30	0.2 / 0.2	2	2

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ORGANICS	CAS #	Cancer Group	10^{-4} Cancer Risk (µg/L)	DWEL (µg/L)	Longer-term HA (Child) (µg/L)	MCL / MCLG (µg/L)	URTH -STAR- Level (µg/L)	Removal Action Level (µg/L)
Malathion	121755	D	—	800	200	—	—	200
Maleic hydrazide	123331	D	—	20,000	5,000	—	—	5,000
MCPA (4-Chloro-2-methylphenoxy)-acetic acid)	94746	E	—	50	100	—	—	50
Methomyl	16752775	D	—	900	300	—	—	300
Methoxychlor	72435	D	—	200	50	40 / 40	50	50
Methyl bromide (see Bromomethane)								
Methyl chloride (see Chloromethane)								
Methyl ethyl ketone (2-Butanone)	78933	D[a]	—	21,000[a]	—	—	—	21,000
Methyl parathion	298000	D	—	9	30	—	—	9
Methyl tert butyl ether	1634044	D	—	200	500	—	—	200
Methylene bromide (see Dibromomethane)								
Methylene chloride (see Dichloromethane)								
Metolachlor	51218452	C	—	5,000	2,000	—	—	2,000
Metribuzin	21087649	D	—	900	300	—	—	300
Monochloroacetic acid (Chloroacetic acid)	79118	—	—	70[a]	—	—	—	70
Monochlorobenzene (Chlorobenzene)	108907	D	—	700	2,000	100 / 100	700	700
Naphthalene	91203	D	—	100	400	—	—	100
Nitroguanidine	556887	D	—	4,000	10,000	—	—	4,000
Nitrophenols p-	25154556	D	—	300	800	—	—	300
Octachlorocamphene (see Toxaphene)								
Oxamyl	23135220	E	—	900	200	200 / 200	—	200
Paraquat	1910425	E	—	200	50	—	—	50
Pentachloronitrobenzene (PCNB)	82688	C[a]	—	100[a]	—	—	—	100
Pentachlorophenol	87865	B2	30	1,000	300	1 / 0	30	30
Perchloroethylene (see Tetrachloroethylene)								
Phenol	108952	D	—	20,000	6,000	—	—	6,000

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ORGANICS	CAS #	Cancer Group	10^{-4} Cancer Risk (µg/L)	DWEL (µg/L)	Longer-term HA (Child) (µg/L)	MCL / MCLG (µg/L)	URTH -STAR- Level (µg/L)	Removal Action Level (µg/L)
Picloram	1918021	D	—	2,000	700	500 / 500	—	700
Polychlorinated biphenyls (PCBs)	1336363	B2	0.5	—	1	0.5 / 0	0.5	0.5
Prometon	1610180	D	—	500	200	—	—	200
Pronamide (Kerb)	23950585	C	—	3,000	800	—	—	800
Propachlor	1918167	D	—	500	100	—	—	100
Propazine	139402	C	—	700	500	—	—	500
Propham	122429	D	—	600	5,000	—	—	600
Pyrene	129000	D	—	1,100	—	—	—	1,100
RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine)	121824	C	30	100	100	—	—	100
Simazine	122349	C	—	200	70	4 / 4	—	40
Styrene	100425	C	—	7,000	2,000	100 / 100	1,000	1,000
T (2,4,5-)	93765	D	—	350	800	—	—	350
Tackle (see Acifluorfen)								
TCDD (2,3,7,8-) (v) (Dioxin)	1746016	B2	0.00002	0.00004	0.00001	0.00003 / 0	—	0.00003
Tebuthiuron	34014181	D	—	2,000	700	—	—	700
Temik (see Aldicarb)								
Terbacil	5902512	E	—	400	300	—	—	300
Terbufos	13071799	D	—	5	1	—	—	1
Tetrachloroethane (1,1,1,2-)	630206	C	100	1,000	900	—	—	900
Tetrachloroethane (1,1,2,2-)	79345	C[a]	20[a]	—	—	—	—	2
Tetrachloroethylene (Perchloroethylene)	127184	B2[a]	70	500	1,000	5 / 0	70	70
Toluene	108883	D	—	7,000	2,000	1,000 / 1,000	—	2,000
Toxaphene (Octachlorocamphene)	8001352	B2	3	3	—	3 / 0	3	3
TP (2,4,5-) (2(2,4,5-Trichlorophenoxy-propionic acid)	93721	D	—	300	70	50 / 50	70	70
Trichloroacetaldehyde (Chloral) see Chloral hydrate (hydrated form of trichloroacetaldehyde)								
Trichloroacetic acid	76039	C	—	1,300	4,000	— / 100	—	1,000
Trichlorobenzene (1,2,4-)	120821	D	—	400	100	70 / 70	—	100

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Trichlorobenzene (1,3,5-)	108703	D	—	200	600	—	—	200
Trichloroethane (1,1,1-)	71556	D	—	1,000	40,000	200 / 200	1,000	1,000
Trichloroethane (1,1,2-)	79005	C	—	100	400	5 / 3	—	30
Trichloroethylene (Trichloroethene)	79016	B2	300	300	—	5 / 0	300	300
Trichloromethane (see Chloroform)								
Trichlorophenol (2,4,6-)	88062	B2	300	—	—	—	—	300
Trichlorophenoxypropionic acid (2(2,4,5-)) (see 2,4,5-TP)								
Trichloropropane (1,2,3-)	96184	B2	—	200	600	—	—	200
1,1,2-Trichloro-1,2,2-trifluoroethane (see Freon 113)								
Trifluralin	1582098	C	—	300	80	—	—	80
Trinitroglycerol	55630	—	—	—	5	—	—	5
Trinitrotoluene (2,4,6-)	118967	C	100	20	20	—	—	20
Vinyl chloride	75014	A	1.5	—	10	2 / 0	2	2
Vydate (see Oxamyl)								
Xylenes (mixed)	1330207	D	—	60,000	40,000	10,000 / 10,000	40,000	40,000

[a] Based on data from IRIS or HEAST in the absence of a published U.S. EPA, Office of Water value

[b] Technical Grade (tg); 2,4- and 2,6-Dinitrotoluene are unlikely to occur alone

[c] Based on special considerations

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Ammonia	7664417	D	—	—	—	—	—	34,000[a] (taste)
Antimony	7440360	D	—	15	15	6 / 6	—	15
Arsenic	7440382	A	2	—	—	50 / —	--	50
Asbestos >10 µm	1332214	A	700 MFL	—	—	7 MFL / 7 MFL	70 MFL	70 MFL[b]
Barium	7440393	D	—	2,000	—	2,000 / 2,000	—	2,000
Beryllium	7440417	B2	0.8	200	4,000	4 / 4	—	1
Boron	7440428	D	—	3,000	900	—	—	900
Cadmium	7440439	D	—	20	5	5 / 5	5	5
Chloramines	10599903	D[a]	—	3,300	1,000	— / 4,000	—	1,000
Chlorine	7782505	D	—	—	—	— / 4,000	—	—
Chlorine dioxide	10049044	D	—	100	—	— / 80	—	100
Chromium III (see Chromium total)	16065831							
Chromium VI (see Chromium total)	18540299							
Chromium (total)	—	D	—	200	200	100 / 100	200	200
Copper	7440508	D	—	—	—	Treat. T. / 1,300	1,300	1,300
Cyanide	57125	D	—	800	200	200 / 200	—	200
Fluoride	16984488	—	—	—	—	4,000 / 4,000	5,000[c]	5,000
Hypochlorite	7681529	—	—	—	—	— / 4,000	—	—
Hypochlorous acid	7790923	—	—	—	—	— / 4,000	—	—
Lead at tap	7439921	B2	—	—	—	Treat. Tech. / 0	30[c]	30
Manganese	7439965	D[a]	—	200	—	— / 200	—	200
Mercury	7439976	D	—	10	—	2 / 2	10	10
Molybdenum	7439987	D	—	200	10	—	—	10
Nickel	7440020	D	—	600	500	100 / 100	—	500
Nitrate	14797558	D	—	56,000	—	10,000 / 10,000	10,000	10,000
Nitrite	14797650	—	—	—	—	1,000 / 1,000	1,000	1,000
Nitrate+Nitrite	—	—	—	—	—	10,000 / 10,000	10,000	10,000

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Selenium	7782492	—	—	200	—	50 / 50	200	200
Silver	7440224	D	—	200	200	—	—	100[d]
Strontium	7440246	D	—	90,000	25,000	—	—	25,000
Sulfate	7757826	—	—	—	—	—	—	250,000 (aesthetics)
Thallium	7440280	—	—	2	7	2 / 0.5	—	2
Vanadium	7440622	D	—	250[a]	—	—	—	250
White phosphorus	772314	D	—	0.5	—	—	—	0.5
Zinc	7440666	D	—	11,000	3,000	—	—	3,000
Zinc chloride (measured as zinc)	—	D	—	11,000	3,000	—	—	3,000

[a] Based on data from IRIS or HEAST in the absence of a published U.S. EPA, Office of Water value

[b] MFL = million fibers per liter

[c] Based on special considerations

[d] Secondary Maximum Contaminant Level intended to protect general public from argyuria (a cosmetic effect) over a lifetime