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The Vermont Department of Health (Health Department) maintains a list of chemical-specific guidance values that may be used in the evaluation of drinking water supplies. This list is referred to as the Drinking Water Guidance document (Guidance). Chemicals are added at the request of other State of Vermont offices, in response to public concerns or as deemed appropriate by the Health Department.

This memo provides an overview of the source of values in the Guidance, the approach used by the Health Department to develop values, and how the Guidance is currently employed by other State of Vermont programs.

The last comprehensive review and update of the Guidance occurred in 2002. Since that time:

- Updated toxicity information has become available for several chemicals listed in the 2002 Guidance.
- The Health Department has been asked to develop guidance values for chemicals not listed in the 2002 Guidance.
- Exposure to potentially sensitive subpopulations and/or during sensitive stages of life has gained increased attention.
- Potential exposure via inhalation of vapors due to routine household water use has gained increased attention.
- Updated information has become available regarding age-specific water ingestion rates.
- Quantitative human health risk assessment methodology has continued to evolve.

An approach that reflects the considerations noted above, as well as others, is used in the development of Health Department derived guidance values.

For the 2018 Guidance, approximately one-third of the chemicals in the 2002 Guidance were reviewed between 2015 and 2018 and revised as warranted. Some new chemicals were added as well. In general, a brief chemical-specific monograph summarizing the information available for review, proposed guidance value and derivation thereof was prepared. On the monographs, values are generically referred to as Vermont Values (VV) during the derivation process.

The 2018 Guidance in its entirety is included as Attachment 1a.

Each guidance value is based upon the best available information at the time of derivation thus is subject to change as updated information and risk assessment methodologies become available.

SOURCE OF DRINKING WATER GUIDANCE VALUES

Three types of values are included in the Guidance. Collectively, these provide critical information for use in the evaluation of potential health implications that may be associated with exposure to chemicals in tap water.

- Primary Maximum Contaminant Levels (**MCL**s) are legally enforceable standards promulgated by the United States Environmental Protection Agency (U.S. EPA) for use in the regulation of public water systems. Each value represents the highest level of a chemical that is allowed in a public drinking water supply. An MCL reflects consideration of public health concerns due to exposure via ingestion as drinking water and potentially other factors such as cost-benefit analysis, detection limit, and best available treatment technology. MCLs are derived for chemicals with carcinogenic and adverse non-carcinogenic health endpoints. For each chemical with an MCL, that value is used as the drinking water guidance value except in limited cases described below.

- Vermont Health Advisories (**VHA**s) are numeric guidelines researched and derived by the Health Department for chemicals that do not have an MCL. A VHA reflects consideration of public health concerns and analytical laboratory reporting limits. VHAs consider ingestion exposure for all chemicals as well as potential exposure via inhalation of vapors due to household water use for those chemicals that may easily volatilize. VHAs are derived for chemicals with carcinogenic and adverse non-carcinogenic health endpoints. If a VHA is exceeded it does not necessarily follow that that adverse health effects may occur, but exposure should be minimized while further evaluation of the water supply is conducted.

- Vermont Action Levels (**VAL**s) are numeric guidelines researched and derived by the Health Department for a small number of chemicals that have MCLs but are of specific public health interest for Vermont Public Water Systems. Thus, these few chemicals have both a U.S. EPA MCL and a Health Department derived value. The latter is always the more restrictive. The term VAL is used to distinguish these values from those derived by the Health Department for chemicals that do not have an MCL. VALs are concentrations at or above which a specific (priority) procedure will be followed in order to provide adequate protection of public health. Per a 2014 Memorandum of Agreement (MOA) (Attachment 2), the Health Department may derive VALs for benzene, carbon tetrachloride, dibromochloropropane, 1,2-dichloroethane, 1,2-dichloropropane, hexachlorobenzene, pentachlorophenol, tetrachloroethylene, trichloroethylene and vinyl chloride . The process employed to derive VALs is the same as that for VHAs.

In addition, U.S. EPA has also established non-mandatory National Secondary Drinking Water Regulations, referred to as secondary maximum contaminant levels (SMCLs), for 15 contaminants. These values, included in Attachment 1b, are non-enforceable guidelines that may assist public water systems in managing their drinking water for aesthetic considerations (such as taste, color, and odor) and/or cosmetic effects (such as tooth or skin discoloration) (EPA, 2012; EPA, 2017a).

HEALTH DEPARTMENT VHA/VAL DERIVATION PROCESS

In general, drinking water guidance values derived by the Health Department (VHAs and VALs) are generated by combining current toxicity values (*e.g.*, oral reference doses, inhalation reference concentrations, oral cancer slope factors and inhalation unit risks) with a hypothetical residential exposure scenario using standard point estimate risk assessment procedures to derive an estimate of the concentration of **each** individual

chemical or in limited instances, group of chemicals, in tap water that corresponds to a fixed level of risk i.e., a target hazard quotient (HQ) of one for noncarcinogenic (systemic) effects or an incremental lifetime cancer risk (ILCR) of one-in-one million (1×10^{-6}). Where a chemical is known to have both noncarcinogenic and carcinogenic effects and toxicity values are available, a value is derived based on each endpoint with the most appropriate reported as the guidance. See attachment 4 for information on how the Department may address chemicals without toxicity values.

Direct exposure via ingestion as drinking water is considered for all chemicals. In addition, inhalation of vapors due to routine household water use is considered for those chemicals with a vapor pressure greater than one millimeter of mercury or a Henry's Law constant greater than or equal to 1×10^{-5} atmosphere-cubic meter/mole (atm-m3/mol) as these may easily volatilize. Similar criteria are used in current EPA practice (EPA, 2015; EPA, 2017b).

An upper bound volatilization factor of 0.5 Liters/m^3 (L/m^3) is assumed in the assessment of inhalation of vapors due to household water use. This constant was derived based on several assumptions including: volume of water used in a residence for a family of four is 720 L/day, volume of dwelling is 150,000 L, air exchange rate is 0.25 m^3/hour, and average transfer efficiency weighted by water use is 50 percent, i.e., 50 percent of the concentration of a volatile chemical present in water will be transferred into air by all household uses (Andelman, 1990 as presented in EPA, 1991). Review of the Andelman work and extensive conversations with local water use authorities indicates the resulting factor is reasonable and appropriate for use.

Estimates of chemical-specific physical properties, such as Henry's Law constant and vapor pressure, are primarily obtained from the Estimation Programs Interface (EPI) Suite™ which is a screening level tool developed by the U.S. EPA Office of Pollution Prevention and Toxics and Syracuse Research Corporation. In accordance with EPI Suite guidance, experimental (measured) values are used when both experimental and estimated values are available.

Each chemical or group of chemicals is evaluated in isolation. Simultaneous exposure to more than one chemical or group of chemicals in water, exposure via other viable pathways (e.g., dermal), and exposure to other chemicals in other environmental media are not considered. Existing background concentrations of naturally occurring inorganics are generally not taken into account.

In some cases, it is possible that the Health Department derived value may be below naturally occurring levels. In the event a derived value is found to be less than a reasonable analytical laboratory reporting limit, the guidance is set equal to the reporting limit.

Toxicity

Toxicity information and oral and inhalation toxicity values are obtained and reviewed from a number of relevant and appropriate sources including:

- U.S. EPA Integrated Risk Information System
- U.S. EPA Office of Pesticide Programs
- U.S. EPA Office of Research and Development/National Center for Environmental Assessment/Superfund Health Risk Technical Support Center (STSC) Provisional Peer Reviewed Toxicity Values
- International Agency for Research on Cancer
- National Toxicology Program

- California EPA Office of Environmental Health Hazard Assessment
- California Department of Pesticide Regulation
- Agency for Toxic Substances and Disease Registry

In limited instances where no peer reviewed toxicity value is available, the open literature and/or studies provided directly to the Health Department may be considered in the development of a noncancer (threshold based) oral toxicity value for use in the derivation of a guidance value.

Mutagenic Mode of Action

Consistent with U.S. EPA guidance (EPA, 2005a), multipliers termed Age Dependent Adjustment Factors (ADAFs) are used in the evaluation of carcinogens identified by U.S. EPA to operate via a mutagenic mode of action. Per the guidance, ADAFs "…reflect the potential for early-life exposure to make a greater contribution to the cancers appearing later in life."

Chemical-specific ADAFs are used if available.

Otherwise, the following non-chemical specific, default adjustments provided by U.S. EPA are used:

- A 10-fold increase for exposures between the day of birth up until the second birthday.
- A 3-fold increase for exposures between the second birthday up until the sixteenth birthday.
- No adjustment is made for exposures occurring after turning 16 years of age.

Food Quality Protection Act Safety Factor

The Food Quality Protection Act (FQPA) of 1996 amended the Federal Insecticide, Fungicide and Rodenticide Act and the Federal Food, Drugs and Cosmetic Act and significantly revised the way in which pesticides are evaluated by the U.S. EPA.

The FQPA mandates that "in the case of threshold effects, an additional tenfold margin of safety for the pesticide chemical residue and other sources of exposure shall be applied for infants and children to take into account potential pre- and post-natal toxicity and completeness of data with respect to exposure and toxicity to infants and children. Notwithstanding such requirement for an additional margin of safety, the Administrator [of the U.S. EPA] may use a different margin of safety for the pesticide chemical residue only if, on the basis of reliable data, such margin will be safe for infants and children" (FQPA, 1996).

Drinking water guidance values derived by the Health Department for pesticides with threshold type effects may reflect incorporation of a U.S. EPA derived FQPA Safety Factor (SF). The magnitude of the FQPA SF employed is noted on the corresponding chemical-specific monograph.

Exposure

Several conservative assumptions are made in order to estimate the potential intake of a chemical in tap water. In reality, the magnitude and frequency of exposure will vary depending on individual circumstances. The use of such health protective assumptions, which tend to represent reasonable upper bound estimates for longer-term exposures, adds additional conservatism to the guidance values derived.

A summary of the exposure assumptions and factors employed in the development of VHAs and VALs is presented in Table 1.

A 70 year age-weighted approach (birth to age 70 years) is employed in the assessment of carcinogens while a hypothetical young child is generally the focus of noncarcinogenic evaluations.

Any variances are noted on the chemical-specific monographs.

Body Weight Adjusted Water Ingestion Rate (BW_AIR)

The U.S. EPA has recommended that fine age groupings be used in the assessment of potential exposure to children (EPA, 2005b). A series of ten ranges between birth and 21 years of age is recommended for consideration as appropriate.

Consistent with this guidance, the 95th percentile per capita BW_AIR for fine age groupings based on combined direct and indirect water intake from community water supplies for consumers only (EPA, 2008) are used. As warranted, a BW_AIR commensurate with an age group of specific interest for a particular chemical is used in the development of the guidance value. Otherwise, the BW_AIR of 0.175 liters of water per kilogram of body weight per day (L/kg-d) associated with the first year of life is employed as a conservative default.

For those chemicals where reproductive toxicity is identified as the critical effect, due to small sample sizes, the BW_AIR of 0.046 L/kg-d for women between the ages of 15 and 44 years of age instead of that reported for pregnant women is used.

The 95th percentile BW_AIR of 0.044 L/kg-d for all ages for direct and indirect water ingestion from community water for consumers only (EPA, 2004) is used in the assessment of non-threshold, non-mutagenic mode of action carcinogenic effects.

Relative Source Contribution

Consistent with U.S. EPA guidance (EPA, 1990), a Relative Source Contribution (RSC) is incorporated in the development of a VHA or VAL based upon a threshold type, primarily noncarcinogenic, health effect. The RSC represents the portion of an individual's total daily exposure to a specific chemical that is attributed to or allocated to drinking water.

In keeping with the established methodology, a factor generally ranging between 20 and 80 percent is used. The exact value employed is dictated by the type and strength of information available and is noted on the chemical-specific monographs.

Additionally, the EPA Office of Pesticide Programs (OPP) has conducted extensive modeling efforts and derived conservative, age group specific, quantitative estimates of dietary exposure (and in some cases other significant sources of exposure) for many pesticides. In such instances, the chemical-specific oral toxicity value may be adjusted and an RSC employed that reflects this consideration. Overall, use of this approach which incorporates more refined, realistic estimates of potential exposure while providing adequate protection of public health was deemed preferable to using a standard default RSC of 20 percent.

Equations

An overview of general endpoint and exposure route specific equations that may be used in development of Health Department derived guidance values are presented in Attachment 3. These equations combine chemical-specific toxicity information with scenario-specific exposure assumptions to generate a level in tap water estimated to correspond to a fixed level of risk i.e., a target HQ of 1.0 or ILCR of 1×10^{-6}.

INTERAGENCY APPLICATION

As of this writing, the Vermont Agency of Natural Resources (ANR) Environmental Protection Rules (Rules) dictate that Groundwater Quality Standards be adopted. Values presented in the Health Department's Drinking Water Guidance serve as the basis of the ANR Primary Groundwater Quality Standards.

In Chapter 12 of the Rules, entitled the Groundwater Protection Rule and Strategy (GPRS)(VGPRS, 2005), it is specified that the Primary Groundwater Quality Standard (a.k.a. Primary Groundwater Quality Enforcement Standard henceforth Enforcement Standard) for a chemical will be set equal to the U.S. MCL, or if one does not exist, equal to a Health Department derived VHA.

As previously described, a small group of chemicals may have both a U.S. EPA MCL and a Health Department derived value termed a VAL. Per the December 2014 MOA (Attachment 2), in such cases, the VAL is to be used as the Enforcement Standard.

The GPRS also requires that a Preventive Action Level (PAL) be established for each chemical. A PAL is defined as "…a numerical value expressing the detectable concentration of a substance in groundwater the reaching or exceeding of which requires a response under Section 12-803 of [the GPRS]." It is specified that the PAL be set equal to one-tenth the Enforcement Standard for those chemicals deemed to possess "…carcinogenic, mutagenic, or teratogenic properties or interactive effects…" and to one-half for all other chemicals. In those instances where a calculated PAL is below the analytical laboratory reporting limit for the chemical in question, the PAL will be established as the reporting limit. The Health Department provides ANR with recommended PALs.

PALs are considered an early warning mechanism to alert ANR to potential groundwater quality degradation. Specific responses are triggered at lower levels for chemicals associated with more serious potential public health impacts. Section 12-803 details responses that may be taken when a PAL is reached or exceeded.

Enforcement Standards and corresponding PALs are listed in Appendix 1, Table 1 of the GPRS.

Per Section 12-103, provisions of the GPRS apply to all ANR "…permit and regulatory programs that control activities which may affect groundwater." These provision may also be adopted by other entities "…with authority to manage activities that may affect groundwater." This helps ensure that an adequate and consistent level of public health protection is provided across state programs.

For example, in Chapter 21 of the Rules, entitled, the Vermont Water Supply Rule (VWSR, 2010), Section 21-6.15 provides that the Secretary of ANR may adopt a Health Department derived VHA for a contaminant which may be detected in a public water system and for which no U.S. EPA MCL has been established.

Additionally, as of this writing, Section IV Vermont Agency of Agriculture, Food and Markets Regulations for Control of Pesticides in Accordance with 6 V.S.A. Chapter 87 (VAAFM, 1991) which specifies "Restrictions on the Use and Application of Pesticides" in the state of Vermont states "[a]ll pesticide applicators and licensed companies shall use pesticides ...so as not to exceed the primary groundwater quality enforcement standards identified in Appendix 1 of the Groundwater Protection Rule and Strategy in accordance with 10 V.S.A. Chapter 48 [and] shall manage the use of pesticides to reduce the concentration of pesticides in groundwater to the preventive action limits [*sic*] established by Chapter 12.702 of the Groundwater Protection Rule and Strategy when monitoring indicates the presence of pesticide concentrations in groundwater that exceed the preventive action limits [*sic*]."

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TABLE 1
VERMONT DEPARTMENT OF HEALTH DERIVED VALUES
EXPOSURE ASSUMPTIONS, PARAMETER VALUES AND FACTORS

SYMBOL	DEFINITION (units)	VALUE
VV	Vermont Value [Vermont Health Advisory (VHA) or Vermont Action Level (VAL)]	Chemical-Specific
VV_{ING}	Value based on ingestion	Chemical-Specific
VV_{INH}	Value based on inhalation of vapors (due to routine household water use)	Chemical-Specific
$VV_{ING,INH}$	Value based on ingestion and inhalation combined	Chemical-Specific
K	Andelman Volatilization Factor (L/m^3)	0.5
ET	Exposure Time (inhalation) (hours/24 hours)	24
EF	Exposure Frequency (days/365 days)	365
ED	Exposure Duration (years):	
ED_c	Carcinogens (nonthreshold)	70
ED_n	Noncarcinogens (threshold toxicants)	Age Group Specific
AT	Averaging Time (years):	
AT_c	Carcinogens (nonthreshold; lifetime)	70
AT_n	Noncarcinogens (threshold toxicants)	Age Group Specific
BW_AIR	Body Weight Adjusted Water Ingestion Rate (L/kg-d):	
	Over All Ages	0.044
	Women of Childbearing Age (15 – 44 years)	0.046
	Infant (Birth -<1 year)	0.175
ADAF	Age Dependent Adjustment Factors (EPA default values):	
	Birth - < 2 years	10
	2 - < 16 years	3
	16 years$^+$	1
RSC	Relative Source Contribution (unitless)	Chemical-Specific
RfD_o	Chronic Oral Reference Dose (mg/kg-d)	Chemical-Specific
RfC	Chronic Inhalation Reference Concentration (mg/m^3)	Chemical-Specific
CPF_o	Oral Cancer Potency Factor $(mg/kg\text{-}d)^{-1}$	Chemical-Specific
IUR	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Chemical-Specific
TR	Target Incremental Lifetime Cancer Risk (unitless)	1×10^{-6}
THQ	Target Hazard Quotient (unitless)	1

Vermont Department of Health
ATTACHMENT 1a

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Chemical Name	CAS No.	VHA (µg/L)[a]	VAL (µg/L)[a]	MCL (µg/L)[a]
Acetone	**67-64-1**	**949.8**		
Acifluorfen, sodium	**62476-59-9**	**4.5**		
Alachlor	15972-60-8			2
Aldicarb	**116-06-3**	**1[b]**		
Aldicarb sulfone	**1646-88-4**	**1[b]**		
Aldicarb sulfoxide	**1646-87-3**	**1[b]**		
Aldrin	**309-00-2**	**0.1**		
Ametryn	**834-12-8**	**246.8**		
Aminoethyl ethanolamine (AEEA)	**111-41-1**	**20**		
Ammonium sulfamate	**7773-06-0**	**914.3**		
Anatoxin-a	**64285-06-9**	**0.5**		
Anthracene	**120-12-7**	**342.9**		
Antimony	7440-36-0			6
Arsenic	7440-38-2			10
Asbestos	1332-21-4			7E+6 fibers/L (longer than 10µm)
Atrazine	1912-24-9			3
Azoxystrobin	**131860-33-8**	**558.3**		
Barium	7440-39-3			2000
Bendiocarb	**22781-23-3**	**1.7**		
Benefin (Benfluralin)	**1861-40-1**	**5.5**		
Benomyl	**17804-35-2**	**9.5**		
Bensulide	**741-58-2**	**15.6**		
Bentazon	**25057-89-0**	**453.1**		
Benzene	**71-43-2**		**0.5**	5
Benzo(a)pyrene	50-32-8			0.2
Beryllium	7440-41-7			4
Bis(2-chloro-1-methyl ethyl) ether	**108-60-1**	**45.7**		
Bispyribac sodium	**125401-92-5**	**300.2**		
Boron	**7440-42-8**	**869.6**		
Boscalid	**188425-85-6**	**185.7**		
Bromacil	**314-40-9**	**110.9**		
Bromate	15541-45-4			10
Bromochloromethane	**74-97-5**	**7.7**		
Bromomethane (Methyl bromide)	**74-83-9**	**4.8**		
Bromoxynil	**1689-84-5**	**1**		
Butylate	**2008-41-5**	**113.6**		
Cadmium	7440-43-9			5
Carbaryl	**63-25-2**	**26**		
Carbofuran	1563-66-2			40
Carbon tetrachloride	56-23-5		**0.5**	5
Carboxin	**5234-68-4**	**22.3**		
Carfentrazone ethyl	**128639-02-1**	**47.9**		
Chloramben	**133-90-4**	**68.6**		
Chlorantraniliprole	**500008-45-7**	**5208.6**		
Chlordane	12789-03-6			2
Chlorflurenol	**2536-31-4**	**457.1**		
Chlorine	**7782-50-5**			**4000[c]**
Chlorite	7758-19-2			1000
Chlorobenzene	108-90-7			100
Chlorothalonil	**1897-45-6**	**1.6**		
Chlorpyrifos	2921-88-2	20		
Chromium (total)	7440-47-3			100
Copper (at tap)	7440-50-8	1300[d]		
Cyanazine	21725-46-2	1		
Cyanide	143-33-9			200
Cylindrospermopsin	**NA**	**0.5**		
Dalapon	75-99-0			200
Dazomet	533-74-4	88		
Di(2-ethylhexyl)adipate	103-23-1			400
Di(2-ethylhexyl)phthalate	117-81-7			6
Diazinon	333-41-5	0.6		
Dibromochloropropane	**96-12-8**		**0.02**	0.2
Dichlorobenzene (meta)	541-73-1	600[e]		
Dichlorobenzene (ortho)	95-50-1			600
Dichlorobenzene (para)	106-46-7			75

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Dichloroethane (1,1)	75-34-3	70		
Dichloroethane (1,2)	107-06-2		0.5	5
Dichloroethene (1,1)	75-35-4			7
Dichloroethene (cis-1,2)	156-59-2			70
Dichloroethene (trans-1,2)	156-60-5			100
Dichlorophenoxyacetic acid (2,4)	94-75-7			70
Dichloroprop	120-36-5	140		
Dichloropropane (1,2)	**78-87-5**		**0.5**	5
Dieldrin	60-57-1	0.02		
Diethylenetriamine (DETA)	**111-40-0**	**5154**		
Dimethrin	70-38-2	2000		
Dinoseb	88-85-7			7
Dioxane (1,4)	**123-91-1**	**0.3**		
Diphenamid	957-51-7	200		
Diquat	85-00-7			20
Disulfoton	298-04-4	0.3		
Diuron	330-54-1	10		
Endothall	145-73-3			100
Endrin	72-20-8			2
Erioglaucine	**2650-18-2**	**7211.4**		
Ethylbenzene	100-41-4			700
Ethylene dibromide	106-93-4			0.05
Fenamiphos	22224-92-6	2		
Fluoranthene	**206-44-0**	**45.7**		
Fluorene	**86-73-7**	**45.7**		
Fluoride	7681-49-4			4000
Fluxapyroxad	**907204-31-3**	**44.4**		
Fonofos	944-22-9	10		
Formaldehyde	50-00-0	1000		
Glyphosate	1071-83-6			700
Gross Alpha (adjusted)	NA			15 pCi/L[(f)]
Haloacetic acids (total)	NA			60
Halofenozide	112226-61-6	46		
Heptachlor	76-44-8			0.4
Heptachlor epoxide	1024-57-3			0.2
Hexachlorobenzene	**118-74-1**		**0.1**	1
Hexachlorocyclopentadiene	77-47-4			50
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	**121-82-4**	**0.3**		
Lead (at tap)	7439-92-1			15[(d)]
Lead	**7439-92-1**	**1**		
Lindane	58-89-9			0.2
Maneb	12427-38-2	35		
Manganese	**7439-96-5**	**300**		
Mercury (inorganic)	7487-94-7			2
Methoxychlor	72-43-5			40
Methyl ethyl ketone	**78-93-3**	**510.6**		
Methyl parathion	298-00-0	2		
Methyl tert butyl ether (MTBE)	**1634-04-4**	**11.3**		
Methylene chloride	75-09-2			5
Metolachlor	51218-45-2	70		
Microcystin	**NA**	**0.16**		
Molybdenum	7439-98-7	**5.7**		
Monochloramine	**10599-90-3**			**4000[(c)]**
Naphthalene	**91-20-3**	**0.5**		
Nickel	7440-02-0	100		
Nitrate (as N)	14797-55-8			10000
Nitrates/Nitrites (total)	NA			10000
Nitrite (as N)	14797-65-0			1000
O-Phenylphenol (OPP)	**90-43-7**	**764**		
Octahydro-1,3,5,7-tetranitro-1,2,3,5,7-tetrazocine (HMX)	**2691-41-0**	**57.1**		
Oxamyl	23135-22-0			200
Paraquat	1910-42-5	30		
Pentachlorophenol	**87-86-5**		**0.1**	1
Pentaerythriol tetranitrate (PETN)	**78-11-5**	**2.3**		
Perchlorate	**1479-73-0**	**2.2**		
Perfluoroheptanoic acid (PFHpA)	**375-85-9**	**0.02[(g)]**		
Perfluorohexanesulfonic acid (PFHxS)	**355-46-4**	**0.02[(g)]**		
Perfluorononanoic acid (PFNA)	**375-95-1**	**0.02[(g)]**		
Perfluorooctanesulfonic acid (PFOS)	**1763-23-1**	**0.02[(g)]**		
Perfluorooctanoic acid (PFOA)	**335-67-1**	**0.02[(g)]**		

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Picloram	1918-02-1			500
Polychlorinated Biphenyls	1336-36-3			0.5
Propachlor	1918-16-7	90		
Propham	122-42-9	100		
Propoxur (Baygon)	**114-26-1**	**6.2**		
Radium$^{226 \& 228}$	7440-14-4			5 pCi/L
Radon	**010043-92-2**	**4000 pCi/L [(h)]**		
Selenium	7782-49-2			50
Simazine	122-34-9			4
Styrene	100-42-5			100
Tall oil hydroxyethyl imidazoline	**61791-39-7**	**118**		
Tartrazine	**1934-21-0**	**1904.8**		
Tetrachlorodibenzo-p-dioxin (2,3,7,8)	1746-01-6			3.00E-05
Tetrachloroethane (1,1,1,2)	630-20-6	70		
Tetrachloroethylene	**127-18-4**		**1**	5
Thallium	7440-28-0			2
Toluene	108-88-3			1000
Toxaphene	8001-35-2			3
Triazole (1,2,4)	**288-88-0**	**20**		
Triazole metabolites (Conjugated)	**86362-20-1, 28711-29-7 and Triazolylpyruvic acid**	**102.9[(i)]**		
Trichlorobenzene (1,2,3)	**87-61-6**	**0.9**		
Trichlorobenzene (1,2,4)	120-82-1			70
Trichloroethane (1,1,1)	71-55-6			200
Trichloroethane (1,1,2)	79-00-5			5
Trichloroethylene	**79-01-6**		**0.5**	5
Trichlorophenoxyacetic acid (2,4,5)	93-76-5	70		
Trichlorophenoxypropionic acid (2,4,5)	93-72-1			50
Trichloropropane (1,2,3)	**96-18-4**	**0.02**		
Triclopyr	**55335-06-3**	**165.3**		
Trihalomethanes (total)	NA			80
Trimethyl benzene (1,2,3)	**526-73-8**	**23.2[(j)]**		
Trimethyl benzene (1,2,4)	**95-63-6**	**23.2[(j)]**		
Trimethyl benzene (1,3,5)	**108-67-8**	**23.2[(j)]**		
Trinitrotoluene (2,4,6) (TNT)	**118-96-7**	**0.8**		
Triticonazole	**131983-72-7**	**194.3**		
Uranium	7440-61-1			20[(k)]
Vinyl chloride	75-01-4		0.5	2
Xylenes	1330-20-7			10000
Zineb	142-14-3	350		

Notes:

BOLD - value revised from 2002 guidance or added since 2002 list

Value adjusted to reflect analytical laboratory reporting limit

NA - Not Applicable as represents more than one analyte and for microcystin and cylindorspermopsin many congeners may react in the assay

(a) - All units are micrograms per Liter (µg/L) [parts per billion (ppb)] unless otherwise noted

(b) - Sum of of Aldicarb, Aldicarb sulfone and Aldicarb sulfoxide not to exceed 1 µg/L.

(c) - EPA 1998 Final Rule for Disinfectants and Disinfection By-products Maximum Residual Disinfection (MRDL)

(d) - Copper and Lead are regulated using "Action Levels" (40CFR141.8)

(e) - Value for meta based on data for ortho dichlorobenzene

(f) - Adjusted excludes Uranium and Radon

(g) - Sum of PFHpA, PFHxS, PFNA, PFOA and PFOS not to exceed 0.02 µg/L.

(h)- Water results should be interepreted after air results are obtained

(i) - Sum of conjugated triazole metabolites (Triazolylalanine, Triazolylacetic acid, and Triazolylpyruvic acid) not to exceed 102.9 ug/L.

(j) - Sum of 1,2,3-TMB, 1,2,4-TMB and 1,3,5-TMB isomers not exceed 23.2 µg/L for VHA.

(k) - Uranium MCL is the Vermont MCL. Federal MCL is 30 µg/L.

U.S. EPA Secondary Maximum Contaminant Levels[(a)]

Chemical Name	CAS No.	SMCL (µg/L)[(b)]
Aluminum	7429-90-5	50-200
Chloride	7647-14-5	250000
Color	NA	15 Color Units
Copper	7440-50-8	1000
Corrosivity	NA	non-corrosive
Fluoride	7681-49-4	2000
Foaming Agents	NA	500
Iron	7439-89-6	300
Manganese	7439-96-5	50
Odor	NA	3 threshold odor number
pH	NA	6.5-8.5[(c)]
Silver	7440-22-4	100
Sodium	7440-23-5	250000[(d)]
Sulfate	7757-82-6	250000
Total Dissolved Solids	NA	500000
Zinc	7440-66-6	5000

Notes:

NA - Not Applicable

SMCL - U.S. EPA Secondary Maximum Contaminant Level

(a) - The U.S. EPA MCLs presented in Attachment 1 are Primary Maximum Contaminant Levels. For reference purposes, the U.S. EPA Secondary MCLs above are used in regulation of contaminants in drinking water that primarily affect the aesthetic qualities relating to the public acceptance of drinking water (40CFR§143.3). Refer to Chapter 21, the Water Supply Rule,Subchapter 6.13. SMCLs accessed online 1/25/2018 at https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals#what-are-secondary

(b) - All units are micrograms per Liter (µg/L) [parts per billion (ppb)] unless otherwise noted

(c) - pH standard units

(d) - Vermont Secondary Maximum Contaminant Level; Vermont Water Supply Rule 2010,Table 6-2.

ATTACHMENT 3
VERMONT DEPARTMENT OF HEALTH
ENDPOINT AND EXPOSURE ROUTE SPECIFIC EQUATIONS
2018 DRINKING WATER GUIDANCE

- **Carcinogenic**
  - Ingestion

$$VV_{ING}\left(\frac{\mu g}{L}\right) = \frac{TR \times AT_c(70\ yrs) \times 10^3 \frac{\mu g}{mg}}{BW_A IR\left(\frac{L}{kg-d}\right) \times EF\left(\frac{365d}{365d}\right) \times ED_c\ (70\ yrs) \times CPF_0\left(\frac{mg}{kg-day}\right)^{-1}}$$ simplifies to $$\frac{TR \times 10^3 \frac{\mu g}{mg}}{BW_A IR\left(\frac{L}{kg-d}\right) \times CPF_0\left(\frac{mg}{kg-day}\right)^{-1}}$$

  - Inhalation

$$VV_{INH}\left(\frac{\mu g}{L}\right) = \frac{TR \times AT_c(70\ yrs)}{EF\left(\frac{365d}{365d}\right) \times ET\left(\frac{24hrs}{24hrs}\right) \times ED_c(70\ yrs) \times K\left(0.5\ \frac{L}{m^3}\right) \times IUR\left(\frac{\mu g}{m^3}\right)^{-1}}$$ simplifies to $$\frac{TR}{K(0.5\frac{L}{m^3}) \times IUR\left(\frac{\mu g}{m^3}\right)^{-1}}$$

  - Combined Routes of Exposure
    (ingestion + inhalation of vapors due to routine household water use)

$$VV_{ING,INH}\left(\frac{\mu g}{L}\right) = \frac{1}{\frac{1}{VV_{ING}} + \frac{1}{VV_{INH}}}$$

- **Carcinogenic via Mutagenic Mode of Action and EPA Default ADAFs used**
  - Ingestion

$$VV_{ING} = \frac{TR \times AT(70yrs \times 365\frac{d}{yr}) \times 1000\mu g / mg}{CPF_o(\frac{mg}{kg-d})^{-1} \times EF(365\frac{d}{yr}) \times IFWM_{ADJ}(6.598\frac{L-yr}{kg-d})}$$

where $IFWM_{ADJ}$ (L-yr/kg-d) =

$$(ED_{0-<2yr} \times BW_A IR_{0-<2yr} \frac{L}{kg-d} \times 10) + (ED_{2-<6yrs} \times BW_A IR_{2-<6yrs} \frac{L}{kg-d} \times 3) + (ED_{6-<16yrs} \times BW_A IR_{6-<16yrs} \frac{L}{kg-d} \times 3) + (ED_{16-<70yrs} \times BW_A IR_{16-<70yrs} \frac{L}{kg-d} \times 1)$$

  - Inhalation

$$VV_{INH} = \frac{TR \times AT(70yrs \times 365\frac{d}{yr})}{EF(365\frac{d}{yr}) \times K(0.5\frac{L}{m^3}) \times ET(\frac{24hrs}{24hrs}) \times [(ED_{0-<2yr} \times IUR(\frac{\mu g}{m^3})^{-1} \times 10) + (ED_{2-<6yrs} \times IUR(\frac{\mu g}{m^3})^{-1} \times 3) + (ED_{6-<16yrs} \times IUR(\frac{\mu g}{m^3})^{-1} \times 3) + (ED_{16-<70yrs} \times IUR(\frac{\mu g}{m^3})^{-1} \times 1)]}$$

  - Combined Routes of Exposure
    (ingestion + inhalation of vapors due to routine household water use)

$$VV_{ING,INH}\left(\frac{\mu g}{L}\right) = \frac{1}{\frac{1}{VV_{ING}} + \frac{1}{VV_{INH}}}$$

- **Noncarcinogenic**
  - Ingestion

    *RSC applied only here If VV is based solely on ingestion

$$VV_{ING}\left(\frac{\mu g}{L}\right) = \frac{THQ \times AT_n\,(yrs) \times RfD_o(\frac{mg}{kg-d}) \times 10^3 \frac{\mu g}{mg}}{BW_A IR\left(\frac{L}{kg-d}\right) \times EF\left(\frac{365d}{365d}\right) \times ED_n\,(yrs)} \times RSC^* \text{ simplifies to } \frac{THQ \times RfD_o(\frac{mg}{kg-d}) \times 10^3 \frac{\mu g}{mg}}{BW_A IR\left(\frac{L}{kg-d}\right)} \times RSC^*$$

  - Inhalation

    *RSC applied only here If VV is based solely on inhalation of vapors due to routine household water use

$$VV_{INH}\left(\frac{\mu g}{L}\right) = \frac{THQ \times AT_n\,(yrs) \times RfC(\frac{mg}{m^3}) \times 10^3 \frac{\mu g}{mg}}{EF\left(\frac{365d}{365d}\right) \times ED_n\,(yrs) * K(0.5\frac{L}{m^3})} \times RSC^* \text{ simplifies to } \frac{THQ \times RfC(\frac{mg}{m^3}) \times 10^3 \frac{\mu g}{mg}}{K\left(0.5\frac{L}{m^3}\right)} \times RSC^*$$

  - Combined Routes of Exposure

    *RSC applied only here if VV is based on combined routes of exposure

    (ingestion + inhalation of vapors due to routine household water use)

$$VV_{ING,INH}\left(\frac{\mu g}{L}\right) = \frac{1}{\frac{1}{VV_{ING}} + \frac{1}{VV_{INH}}} \times RSC^*$$

ATTACHMENT 2

MOU 03420-6468

MEMORANDUM OF AGREEMENT

Between the

Vermont Department of Health
And
Vermont Department of Environmental Conservation

I. Purpose

The Vermont Department of Environmental Conservation (DEC) is responsible for regulation of public water systems and hazardous site cleanups in the State of Vermont. The Vermont Department of Health (Health) is responsible for overseeing public health in Vermont. In fulfilling these responsibilities, both departments have a role to play in drinking water contamination.

This memorandum of agreement specifies how DEC and Health will jointly respond to certain contamination incidents at Vermont public water systems. Specifically, the agreement concerns detections of chemicals between the Vermont Action Level, as defined below, and the Maximum Contaminant Level (MCL), the enforceable standard under state and federal regulations. Contaminant concentrations lower than the Vermont Action Level or exceeding the MCL are not included in this agreement and will be managed as they have historically been between the departments.

By their signatures below, the respective commissioners agree to follow the procedures described herein.

II. Terms and Agreement

A. Vermont Health Advisories

For chemicals for which there is no U.S. Environmental Protection Agency or DEC MCL, Health may establish or maintain Vermont Health Advisories which may be managed as MCLs for the purpose of public water system regulation. A Vermont Health Advisory means the concentration of a substance in drinking water below which the water does not pose a public health risk, or public health hazard as defined in 18 V.S.A. Chapter 1 .

B. Establishment of Vermont Action Level

Vermont Action Levels are developed by Health for a small number of chemicals that have MCLs but are of specific public health concern. Vermont Action Levels are more restrictive than corresponding MCLs. A Vermont Action Level is defined as the concentration of a substance in drinking water which clearly provides adequate public health protection, as determined by Health. The contaminants listed in the table below will have Vermont Action Levels. Vermont Action Levels and Vermont Health Advisories will be listed in the Drinking

Water Guidance document on the Health Department website, and are used for both public water systems and private (well) water supplies. The Vermont Health Advisories are included as Ground Water Enforcement Standards in Appendix 1 of the Ground Water Protection Rule and Strategy. The Vermont Action Levels shall also be added to Appendix 1 as Ground Water Enforcement Standards.

Chemical Name	CAS number	Vermont Action Level (µg/L)
benzene	71-43-2	0.5
carbon tetrachloride	56-23-5	0.5
dibromochloropropane	96-12-8	0.02
1,2 dichloroethane	107-06-2	0.5
1,2 dichloropropane	78-87-5	0.5
hexachlorobenzene	118-74-1	0.1
pentachlorophenol	87-86-5	0.1
tetrachloroethylene	127-18-4	1
trichloroethylene	79-01-6	0.5
vinyl chloride	75-01-4	0.5

C. Procedures to be Followed if the Vermont Action Level is Exceeded
In the event that routine monitoring by public water systems detects one of the contaminants listed in II B at levels above the Vermont Action Level, the parties agree to perform the following steps.

(1) Immediate Resampling
DEC will insure that the system is resampled immediately and reanalyzed to confirm the initial detection. No action will be required of the public water system until the resampling and analysis is completed, except in unusual circumstances when DEC and Health agree that the results of the first detection warrant immediate action.

(2) Conducting of Risk Assessment
If the resampling and analysis confirms the initial detection, and the concentration reported is between the Vermont Action Level and the MCL, DEC will advise Health and will request in writing that Health conduct a risk assessment based on the information known about the public water system. DEC will provide any additional pertinent information it may have about the system that could assist in performing the risk assessment.

(3) Issuance of Public Notice
Once confirmed, DEC will require the public water system to issue public notice announcing the detection, including any health effects language then available, and stating that DEC is working on the problem in conjunction with the public water system and Health.

(4) Determination of Risk
Health will provide DEC with a written assessment of the risk, as well as in its judgment whether DEC should require a Do Not Drink or other appropriate advisory.

(5) Issuance/Amendment of the Public Water System Operating Permit
In the event that the Secretary of the Agency of Natural Resources, after consultation with Health, determines a significant public health risk exists, DEC will issue or revise the Operating Permit for the system. The permit will contain a schedule for the public water system to address the contamination. The specific schedule would be determined by DEC, taking into account the risk assessment and other public health advice from Health as well as other factors such as the technical feasibility of addressing the source of contamination and/or reducing the level of chemical in finished water, availability of financial support, and the ability of the system and rate payers to pay for the needed improvements.

(6) Issuance of Periodic Public Notice
Until analytical laboratory results indicate that the level of chemical present has been reduced to below the Vermont Action Level, DEC will require the system issue periodic pubic notice to its customers so that they are appropriately informed.

D. Cooperation of Parties
In all matters associated with this agreement, both parties agree to work jointly and in good faith, and that neither party will act unilaterally until the matters have been discussed between them. Nothing in this agreement shall prohibit either of the parties from taking any legally authorized action which such party deems necessary to take in order to protect public health.

E. Other Drinking Water Contamination Incidents
For drinking water contamination incidents not covered by this agreement, the parties agree to work jointly in addressing the incidents. Where feasible, the parties will follow this or a similar process to inform the public water systems' customers and to resolve the problem.

III. Changes or Amendments to this MOA
Any changes to this Memorandum of Agreement may be made only by the mutual written agreement of all parties.

IV. Termination
The parties agree that each has the right to terminate the relationship within 30 days of sending a written notice to the other parties.

V. Effective Date

This Memorandum of Agreement shall be in effect upon signing and shall be reviewed every three years.

By signing this agreement all parties agree upon all the terms as stated above.

Agreed upon by:

Signature: _____

Name/Title: Tracy Dolan, Acting Commissioner of Health

Date: 12/18/14

Signature: _____

Name/Title: David Mears, Commissioner of Department of Environmental Conservation

Date: 12/19/14

Attachment 4

Grouping Process for Drinking Water Health Advisories

The State of Vermont uses Maximum Contaminant Levels (MCL) when established by the EPA (except for 10 chemicals agreed to by Health and DEC in a 2014 memo). Hundreds of chemicals have MCLs. For chemicals without an MCL, the Health Department may set Drinking Water Health Advisories. Health Advisories are developed:

(1) at the request of other State of Vermont Agencies,
(2) in response to public concerns, or
(3) when the Health Department determines people may be exposed.

Example 1: DEC notified the Health Department in February 2016 they would be testing drinking water for PFOA, and requested a Health Advisory. The Agency of Agriculture requests Health Advisories for pesticides allowed under their permit programs. The Health Department initiated updated Health Advisories in 2016 for trimethylbenzenes when the updated EPA IRIS risk assessment was released.

Health Advisories are established for various chemicals based on the toxicity data available for each chemical. This memorandum outlines the process and rationale behind the development of Health Advisories including when no toxicity values are available for a chemical that is under investigation in Vermont (situations 3 and 4 below). Decision points and any variances are noted on chemical-specific monographs.

Toxicity Values Available – Majority of Vermont Health Advisories

1. For chemicals that have established toxicity values from authoritative sources, for example the United States Environmental Protection Agency (U.S. EPA), the best available toxicity value is selected for use in the derivation of the Health Advisory as outlined in the Drinking Water Guidance.

Example 2: This applies to most of the chemicals for which the Department has derived a Health Advisory, including trimethylbenzenes and PFOA.

Toxicity Values Not Available – Minority of Vermont Health Advisories

2. In limited instances where no peer reviewed toxicity value is available, the open literature and/or studies provided to the Health Department may be considered in the development of a potential noncancer oral toxicity value for use in the derivation of a Health Advisory.

Example 3: For example, a toxicity study is currently ongoing for the lampricide TFM. The data from the toxicity study will be used by the Health Department to derive a toxicity value. In 2011, the Health Department reviewed published literature to select a study upon which to base a toxicity value for anatoxin.

3. For chemicals that do not have established toxicity values from authoritative sources but are part of a group of chemicals in which one or more chemicals do have toxicity values, a single

Health Advisory may be developed that is applicable to the sum of multiple contaminants, including chemicals that do not have toxicity values.

Example 4: PFHxS, PFHpA, and PFNA are being evaluated in drinking water by DEC. These chemicals do not have toxicity values, but meet the criteria to be grouped with PFOA and PFOS.

This process is followed when the following four conditions are met:

A. The chemical or group of chemicals is found or being investigated in Vermont,
B. The chemicals are sufficiently similar,
C. The chemicals are often found together, and
D. The chemicals elicit similar health effects.

In these unusual instances, the Health Department:

A. Reviews the available science for the chemicals, including documents published from US EPA and ATSDR,
B. Consults with federal and other state agencies regarding advice for the protection of public health, including the US EPA and ATSDR,
C. Consults with other health departments that have evaluated the chemical in question
D. The Department evaluates the four criteria outlined above. The designation of sufficient similarity may be made by the Health Department considering current science and designations of other authoritative governmental bodies. Groups of chemicals with similar structural formula, physical and chemical properties (such as solubility) and similar environmental fate (such as persistence and the ability to migrate in the environment) are often found together. Similar health effects are defined as the biological effects observed in animal or human studies after exposure to the chemical. This could include effects on the same organs or systems or the same type of health effect such as a specific type of cancer. Because people may be exposed to multiple chemicals in a group at a time, when the chemicals elicit similar health effects, it may be appropriate to assess the health risks posed by the group of chemicals under one Health Advisory.

There is precedent for developing a single guidance value that is applicable to the sum of multiple drinking water contaminants when they are sufficiently similar, often found together, and elicit similar health effects. The U.S. EPA has applied this concept to chemicals including, but not limited to:

- Polychlorinated biphenyls (PCBs): PCBs are a group of chemicals that contain 209 individual compounds. Toxicity values do not exist for all 209 PCBs. Fourteen PCBs are grouped separately from the other 195 PCBs. The 14 PCBs are the most toxic PCBs and are compared in their potency to the most toxic dioxin[1]. For the 195 remaining PCBs, U.S. EPA uses a toxicity value from a specific combination of several PCBs to assess toxicity of the PCBs that do not have toxicity values.[2]
- Haloacetic acid disinfection byproducts: EPA established an MCL (Maximum Contaminant Level) for five haloacetic acids (HAA5). The HAA5 are dichloroacetic acid, trichloroacetic acid, monochloroacetic acid, bromoacetic acid, and dibromoacetic acid. Toxicity values exist for only two of the five chemicals in the HAA5 group. U.S. EPA established one MCL which is applicable to the sum of HAA5[3].

The Advisory Review Process for the establishment of a single Health Advisory applicable to the sum of multiple contaminants begins with the Health Department consulting with federal and other state agencies. The State Radiological and Toxicological Risk Assessor, Senior Drinking Water Engineer, and Toxicological and Radiological Analyst consult with the State Toxicologist. The State Toxicologist then consults with the State Epidemiologist for Environmental Health. The Deputy Commissioner of Health, Senior Legal and Policy Advisor, and Commissioner of Health are consulted, and the Commissioner makes the final decision.

4. The analytical laboratory reporting level serves as the Health Advisory when no toxicity value is available and there is insufficient information upon which to base a noncancer oral toxicity value, and when the chemical in question can not be grouped with another chemical with an existing toxicity value.

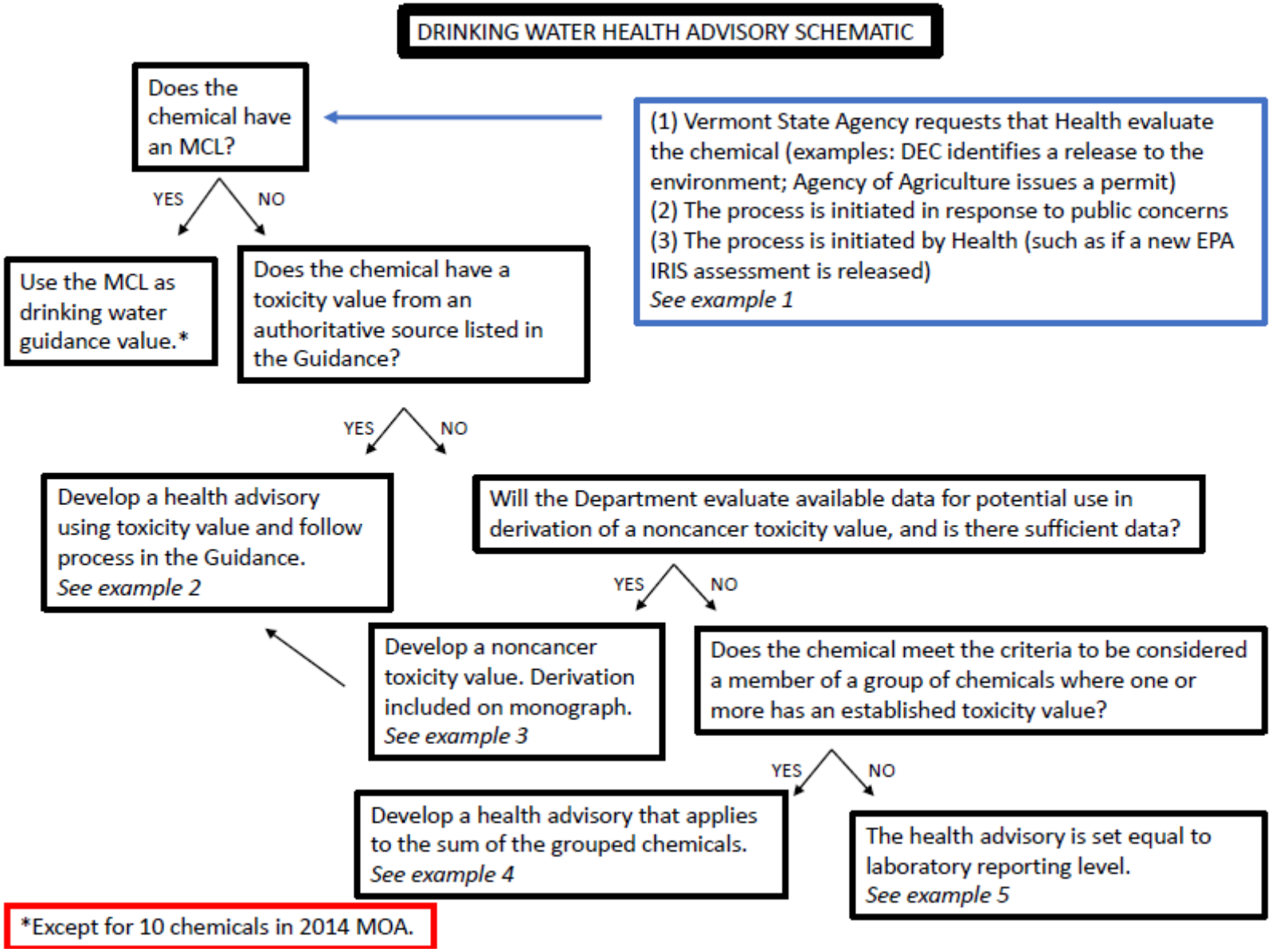
Example 5: For example, in 2016 the LaPlatte River was proposed for TFM treatment. The Champlain Water District intake is located at the mouth of the LaPlatte, and contamination of the public water system was anticipated. There is no MCL for TFM, no toxicity value for TFM, no data upon which to base a toxicity value, and no group of chemicals with toxicity values in which TFM could be grouped. The Health Department recommended water containing TFM above the reporting level not be used for drinking, cooking or food preparation.

References:

1. https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide-november-2017#toxicity

2. https://www.epa.gov/sites/production/files/2016-09/documents/polychlorinated-biphenyls.pdf

3. Federal Register, 69408 Federal Register / Vol. 63, No. 241 / Wednesday, December 16, 1998 / Rules and Regulations


DRINKING WATER HEALTH ADVISORY SCHEMATIC
Does the chemical have an MCL?
YES
NO
Use the MCL as drinking water guidance value.*
Does the chemical have a toxicity value from an authoritative source listed in the Guidance?
(1) Vermont State Agency requests that Health evaluate the chemical (examples: DEC identifies a release to the environment; Agency of Agriculture issues a permit)
(2) The process is initiated in response to public concerns
(3) The process is initiated by Health (such as if a new EPA IRIS assessment is released)
See example 1
YES
NO
Develop a health advisory using toxicity value and follow process in the Guidance.
See example 2
Will the Department evaluate available data for potential use in derivation of a noncancer toxicity value, and is there sufficient data?
YES
NO
Develop a noncancer toxicity value. Derivation included on monograph.
See example 3
Does the chemical meet the criteria to be considered a member of a group of chemicals where one or more has an established toxicity value?
YES
NO
Develop a health advisory that applies to the sum of the grouped chemicals.
See example 4
The health advisory is set equal to laboratory reporting level.
See example 5
*Except for 10 chemicals in 2014 MOA.