Amendments to 15A NCAC 02L .0202 Groundwater Quality Standards: Supporting Information

Table of Contents

North Carolina Proposed Groundwater Standard Summary Table: Group 1

						15A NCAC 02L .0202(d) Groundwater quality standards for substances are established as the least of (1-6):									
Group	**Compound**	**CAS #**	**Current IMAC (µg/L)**	**Proposed Groundwater Standard (µg/L)**	**Basis of Proposed Groundwater Standard**	**1: Systemic/Non-cancer Threshold Concentration (µg/L)**	**2: Concentration at 10^{-6} lifetime cancer risk (µg/L)**	**3: Taste Threshold (µg/L)**	**4: Odor Threshold (µg/L)**	**5: Federal Maximum Contaminant Level (µg/L)**	**6: National Secondary Drinking Water Standard (µg/L)**	**Practical Quantitation Limit (PQL) (µg/L)***	**Naturally Occuring****	**Cost/Benefit to regulated parties, as compared to IMAC (assume is driver)**	**Cost/Benefit to regulated parties, as compared to PQL (assume is driver)**
1	Antimony	7440-36-0	1	1	*Based on non-cancer threshold concentration.*	**1.4**	NA	NA	NA	6	NA	10	possible	none	none
1	Beryllium	7440-41-7	4	4	*Based on Federal MCL.*	7	NA	NA	NA	**4**	NA	5	possible	none	none
1	Cobalt	7440-48-4	1	1	*Based on non-cancer threshold concentration.*	**1.05**	NA	NA	NA	NA	NA	50	possible	none	none
1	Strontium	7440-24-6	none	2,000	*Based on non-cancer threshold concentration.*	**2,100**	NA	NA	NA	NA	NA	10	possible	none	benefit
1	Thallium	7440-28-0	0.2	2	*Based on Federal MCL.*	NA	NA	NA	NA	**2**	NA	2	possible	benefit	none
1	Tin (inorganic forms)	7440-31-5	2,000	2,000	*Based on non-cancer threshold concentration.*	**2,100**	NA	NA	NA	NA	NA	10	possible	none	benefit
1	Vanadium	7440-62-2	0.3	7	*Based on non-cancer threshold concentration.*	**7**	NA	NA	NA	NA	NA	10	possible	benefit	none

*PQL provided for informational purposes only; not used in the calculation or selection of groundwater standards.
**15A NCAC 02L .0202(b)(3) states that "where naturally occurring substances exceed the established standard, the standard shall be the naturally occurring concentration as determined by the Director" of Water Resources.

North Carolina Proposed Groundwater Standard Summary Table: Group 2

						15A NCAC 02L .0202(d) Groundwater quality standards for substances are established as the least of (1-6):									
Group	Compound	CAS #	Current IMAC (µg/L)	Proposed Groundwater Standard (µg/L)	Basis of Proposed Groundwater Standard	1: Systemic/Non-cancer Threshold Concentration (µg/L)	2: Concentration at 10^{-6} lifetime cancer risk (µg/L)	3: Taste Threshold (µg/L)	4: Odor Threshold (µg/L)	5: Federal Maximum Contaminant Level (µg/L)	6: National Secondary Drinking Water Standard (µg/L)	Practical Quantitation Limit (PQL) (µg/L)*	Naturally Occuring	Cost/Benefit to regulated parties, as compared to IMAC (assume is driver)	Cost/Benefit to regulated parties, as compared to PQL (assume is driver)
2	Acrolein	107-02-8	4	4	*Based on non-cancer threshold concentration.*	**4**	NA	NA	110	NA	NA	5	no	none	none
2	Alachlor	15972-60-8	0.4	2	*Based on Federal MCL.*	70	NA	NA	NA	**2**	NA	4	no	benefit	none
2	Aldrin	309-00-2	0.002	0.002	*Based on 10^{-6} cancer risk.*	0.21	**0.002**	NA	NA	NA	NA	0.03	no	none	none
2	Dichloroacetic Acid	79-43-6	0.7	0.7	*Based on 10^{-6} cancer risk.*	28	**0.7**	NA	NA	NA	NA	1	no	none	none
2	2,4-Dichlorophenol	120-83-2	0.98	0.98	*Based on taste threshold.*	21	NA	**0.98**	5.4	NA	NA	10	no	none	none
2	2,4-Dinitrotoluene	121-14-2	0.1	0.05	*Based on 10^{-6} cancer risk.*	14	**0.05**	NA	NA	NA	NA	10	no	cost	none
2	2,6-Dinitrotoluene	606-20-2	none	0.05	*Based on 10^{-6} cancer risk.*	7	**0.05**	NA	NA	NA	NA	10	no	none	none
2	1,2,4,5-Tetrachlorobenzene	95-94-3	2	2	*Based on non-cancer threshold concentration.*	**2.1**	NA	NA	NA	NA	NA	2	no	none	none
2	1,1,1,2-Tetrachloroethane	630-20-6	1	1	*Based on 10^{-6} cancer risk.*	210	**1.35**	NA	NA	NA	NA	1	no	none	none
2	1,1,2- Trichloroethane	79-00-5	0.6	0.6	*Based on 10^{-6} cancer risk.*	28	**0.614**	NA	NA	5	NA	1	no	none	none
2	2,4,6-Trichlorophenol	88-06-2	4	3	*Based on 10^{-6} cancer risk. (calculation input error corrected)*	7	**3.5**	380	12	NA	NA	10	no	none	none

*PQL provided for informational purposes only; not used in the calculation or selection of groundwater standards.
**15A NCAC 02L .0202(b)(3) states that "where naturally occurring substances exceed the established standard, the standard shall be the naturally occurring concentration as determined by the Director" of Water Resources.

North Carolina Proposed Groundwater Standard Summary Table: Group 3

						15A NCAC 02L .0202(d) Groundwater quality standards for substances are established as the least of (1-6):									
Group	**Compound**	**CAS #**	**Current IMAC (µg/L)**	**Proposed Groundwater Standard (µg/L)**	**Basis of Proposed Groundwater Standard**	**1: Systemic/Non-cancer Threshold Concentration (µg/L)**	**2: Concentration at 10^{-6} lifetime cancer risk (µg/L)**	**3: Taste Threshold (µg/L)**	**4: Odor Threshold (µg/L)**	**5: Federal Maximum Contaminant Level (µg/L)**	**6: National Secondary Drinking Water Standard (µg/L)**	**Practical Quantitation Limit (PQL) (µg/L)***	**Naturally Occuring**	**Cost/Benefit to regulated parties, as compared to IMAC (assume is driver)**	**Cost/Benefit to regulated parties, as compared to PQL (assume is driver)**
3	Acetic acid	64-19-7	5,000	5,000	*Based on non-cancer threshold concentration.*	**5,000**	NA	22,000	97,000	NA	NA	1,000	no	none	benefit
3	Acetochlor	34256-82-1	100	100	*Based on non-cancer threshold concentration.*	**140**	NA	NA	NA	NA	NA	4.0	no	none	benefit
3	Acetochlor ESA	187022-11-3	1,000	500	*Based on non-cancer threshold concentration.*	**525**	NA	NA	NA	NA	NA	0.4	no	cost	benefit
3	Acetochlor OXA	184992-44-4	1,000	500	*Based on non-cancer threshold concentration.*	**525**	NA	NA	NA	NA	NA	0.5	no	cost	benefit
3	Acetophenone	98-86-2	700	700	*Based on non-cancer threshold concentration.*	**700**	NA	NA	68,000	NA	NA	2	no	none	benefit
3	Benzyl Alcohol	100-51-6	700	700	*Based on non-cancer threshold concentration.*	**700**	NA	NA	NA	NA	NA	30	no	none	benefit
3	Bromomethane	74-83-9	10	10	*Based on non-cancer threshold concentration.*	**9.8**	NA	NA	NA	NA	NA	1	no	none	benefit
3	Butanol, n-	71-36-3	700	590	*Based on odor threshold.*	700	NA	NA	**590**	NA	NA	50	no	cost	benefit
3	Butanol, sec-	78-92-2	10,000	10,000	*Based on non-cancer threshold concentration.*	**14,000**	NA	NA	19,000	NA	NA	250	no	none	benefit
3	4-Chlorotoluene	106-43-4	24	24	*Based on taste threshold.*	490	NA	**24**	60	NA	NA	1	no	none	benefit
3	Dalapon	75-99-0	200	200	*Based on non-cancer threshold/Federal MCL.*	210	NA	NA	>11,000	**200**	NA	4	no	none	benefit
3	1,4-Dibromobenzene	106-37-06	70	70	*Based on non-cancer threshold concentration.*	**70**	NA	NA	NA	NA	NA	1	no	none	benefit
3	p,p'-DDE	72-55-9	0.1	0.1	*Based on 10^{-6} cancer risk.*	NA	**0.1**	NA	NA	NA	NA	0.03	no	none	benefit
3	Dinoseb	85-85-7	7	7	*Based on non-cancer threshold concentration / Federal MCL.*	**7**	NA	NA	NA	**7**	NA	0.6	no	none	benefit
3	Diphenyl Ether	101-84-8	100	180	*Based on odor threshold.*	NA	NA	NA	**180**	NA	NA	2	no	benefit	benefit
3	Diquat	85-00-7	20	20	*Based on non-cancer threshold concentration / Federal MCL.*	**15.4**	NA	56	8,900	**20**	NA	2	no	none	benefit
3	Endosulfan Sulfate	1031-07-8	40	40	*Based on non-cancer threshold concentration.*	**40**	NA	NA	NA	NA	NA	0.03	no	none	benefit
3	Endothall	145-73-3	100	100	*Based on non-cancer threshold concentration / Federal MCL.*	**140**	NA	NA	NA	**100**	NA	10	no	none	benefit

*PQL provided for informational purposes only; not used in the calculation or selection of groundwater standards.
**15A NCAC 02L .0202(b)(3) states that "where naturally occurring substances exceed the established standard, the standard shall be the naturally occurring concentration as determined by the Director" of Water Resources.

North Carolina Proposed Groundwater Standard Summary Table: Group 3

						15A NCAC 02L .0202(d) Groundwater quality standards for substances are established as the least of (1-6):									
Group	Compound	CAS #	Current IMAC (µg/L)	Proposed Groundwater Standard (µg/L)	Basis of Proposed Groundwater Standard	1: Systemic/Non-cancer Threshold Concentration (µg/L)	2: Concentration at 10^{-6} lifetime cancer risk (µg/L)	3: Taste Threshold (µg/L)	4: Odor Threshold (µg/L)	5: Federal Maximum Contaminant Level (µg/L)	6: National Secondary Drinking Water Standard (µg/L)	Practical Quantitation Limit (PQL) (µg/L)*	Naturally Occuring	Cost/Benefit to regulated parties, as compared to IMAC (assume is driver)	Cost/Benefit to regulated parties, as compared to PQL (assume is driver)
3	alpha-Hexachlorocyclohexane	319-84-6	0.006	0.006	*Based on 10^{-6} cancer risk.*	60	**0.006**	NA	NA	NA	NA	0.0013	no	none	benefit
3	beta-Hexachlorocyclohexane	319-85-7	0.02	0.02	*Based on 10^{-6} cancer risk.*	NA	**0.02**	NA	NA	NA	NA	0.0013	no	none	benefit
3	4-Isopropyltoluene	99-87-6	25	25	*Based on odor threshold.*	70	NA	NA	**25**	NA	NA	1	no	none	benefit
3	Methyl Butyl Ketone (2-Hexanone)	591-78-6	40	40	*Based on non-cancer threshold concentration.*	**35**	NA	NA	250	NA	NA	5	no	none	benefit
3	Methyl Isobutyl Ketone	108-10-1	100	100	*Based on non-cancer threshold concentration.*	**119**	NA	NA	1,300	NA	NA	10	no	none	benefit
3	Methyl Methacrylate	80-62-6	25	25	*Based on odor threshold.*	9,800	NA	NA	**25**	NA	NA	2	no	none	benefit
3	1-Methylnaphthalene	90-12-0	1	1	*Based on 10^{-6} cancer risk.*	50	**1**	NA	7.5	NA	NA	0.5	no	none	benefit
3	2-Methylphenol	95-48-7	400	400	*Based on non-cancer threshold concentration.*	**400**	NA	NA	NA	NA	NA	10	no	none	benefit
3	Perfluorooctane Sulfonic Acid (PFOS) and Perfluorooctanoic Acid (PFOA), total	1763-23-1	none	0.07	*Based on EPA Office of Water Drinking Water Health Advisory (0.07 µg/L for total PFOA and PFOS)*	0.1	0.5	NA	NA	NA	NA	0.002	no	benefits of PFOS potentially offset by costs of PFOA	benefit
		335-67-1	2	0.07	*Based on EPA Office of Water Drinking Water Health Advisory (0.07 µg/L for total PFOA and PFOS)*	0.1	NA	NA	NA	NA	NA	0.002	no		
3	Propylene Glycol	57-55-6	140,000	100,000	*Based on non-cancer threshold concentration. (rounding error corrected)*	**140,000**	NA	NA	NA	NA	NA	10,000	no	none	benefit
3	2,4,5-Trichlorophenol	95-95-4	63	63	*Based on odor threshold.*	700	NA	100	**63**	NA	NA	10	no	none	benefit

*PQL provided for informational purposes only; not used in the calculation or selection of groundwater standards.

**15A NCAC 02L .0202(b)(3) states that "where naturally occurring substances exceed the established standard, the standard shall be the naturally occurring concentration as determined by the Director" of Water Resources.

Groundwater Standard Summary Document
Division of Water Resources

ANTIMONY (7440-36-0)

Health Effects Summary
Human health effects associated with low environmental exposures to antimony are unknown. There are limited good quality studies assessing the toxicological properties of antimony. Adults ingesting antimony trioxide-contaminated lemonade with an estimated concentration of 0.5 mg antimony /kg body weight reported stomach pains, colic, nausea, and vomiting. Long-term drinking water studies in mice and rats (using aqueous potassium antimony tartrate) reported decreased survival and changes in glucose and cholesterol level.

Data used for Groundwater Standard
US EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.0004 mg/kg-day for antimony based on decreased survival and changes in glucose and cholesterol levels in a long-term rat study (https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0006_summary.pdf). A systemic threshold concentration of 1 ug/L (ppb) can be calculated using the oral reference dose for antimony in accordance with 15A NCAC 02L .0202(d)(1).

US EPA has not established a carcinogenicity classification for antimony due to lack of data indicating carcinogenic effects by ingestion. A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

No odor threshold, taste threshold, or secondary drinking water standard has been established for antimony. A federal Maximum Contaminant Level (MCL) of 6 µg/L has been established for antimony. The MCL is equal to the maximum contaminant level goal (MCLG) of 0.0006 mg/L published in 57 FR 31776 (7-17-92)). The MCLG is based on Schroeder et al., 1970 and assumes a relative source contribution factor of 40%. The MCLG is based on the same study selected for derivation of an RfD by the EPA IRIS and PPRTV programs.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 1 µg/L was established under 15A NCAC 02L .0202(c) for antimony in 2010. The calculated threshold concentration of 1.4 µg/L was rounded down to 1 µg/L in accordance with rounding conventions. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for antimony is 1 ug/L (ppb) based on the calculated noncancer systemic threshold.

Uses:
Elemental antimony is alloyed with lead and other metals to increase hardness and impart desirable qualities such as corrosion resistance and electrochemical stability. Antimony trioxide is used predominantly as a fire retardant. Antimony compounds are also used therapeutically in the treatment of parasitic diseases such as leishmaniasis and schistosomiasis.

References

Agency for Toxic Substances and Disease Registry. Toxicological Profile for Antimony. 1992. http://www.atsdr.cdc.gov/

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

Schroeder, HA, Mitchner M, and Nasor AP. 1970. Zirconium, Niobium, Antimony, Vanadium and lead in rats: Life term studies. Journal of Nutrition, 100, 59-68.

U.S. EPA. Ambient Water Quality Criteria Document for Antimony 1980. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Water, Regulations and Standards Division, Washington, DC. EPA-440/5-80-020. NTIS PB 81- 117319.

U.S. EPA. Drinking Water Standards and Health Advisories. 2012. Office of Water (EPA 822-S-12-001) https://www.epa.gov/sites/production/files/2015-09/documents/dwstandards2012.pdf

U.S. EPA. Provisional Peer Reviewed Toxicity Values for Soluble Antimony Compounds. 2008. Office of Research and Development, National Center for Environmental Assessment https://hhpprtv.ornl.gov/quickview/pprtv_papers.php

U.S. EPA Integrated Risk Information System. 1987. IRIS Summary for Antimony. http://www.epa.gov/iris (accessed June 15, 2016).

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Antimony CASRN 7440-36-0

North Carolina Groundwater (GW) Standard = 1 µg/L

Summary The North Carolina GW standard for antimony is based on a non-cancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Decreased survival and changes in glucose and cholesterol levels (lifetime rat study).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	4.0E-04	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.1	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**1.4**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	$(mg/kg/day)^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**6**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[9]

10 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 6/16/16). IRIS assessment last revised 1/31/87. Schroeder, H.A., M. Mitchner and A.P. Nasor. 1970. Zirconium, niobium, antimony, vanadium and lead in rats: Life term studies. J. Nutrition. 100: 59-66.
[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).
[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).
[4] NA; Antimony has not been classified for carcinogenicity by EPA. A cancer potency factor is not available.
[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.
[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.
[7] MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 6/16/2016).
[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.
[9] PQL provided for informational purposes only. PQL established by North Carolina Water Quality lab (https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/microbiology-inorganics-branch/methods-pqls-qa)

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

February 10, 2010 - Division of Waste Management (DWM) requested IMAC for antimony.
August 1, 2010 - IMAC of 1 µg/L approved by DWQ director.

Groundwater Standard Summary Document
Division of Water Resources

BERYLLIUM (CASRN 7440-41-7)

Health Effects Summary
Human health effects associated with low environmental exposures to beryllium are unknown. Following ingestion, very little beryllium is absorbed from the stomach and intestines. Systemic effects reported in long term oral feeding and drinking water studies with animal include increased mortality due to ulcerative gastrointestinal lesions in dogs and rickets in rats.

Data used for Groundwater Standard
US EPA's Integrated Risk Information System (IRIS, 1998) established an oral reference dose (RfD) of 0.002 mg/kg-day for beryllium based on small intestinal lesions in a feeding study in dogs (Morgareidge et al., 1976). A systemic threshold concentration of 7 ug/L (ppb) can be calculated using the oral reference dose for beryllium in accordance with 15A NCAC 02L .0202(d)(1).

US EPA has not classified beryllium and its compounds for its carcinogenic potential via ingestion due to inadequate information. Therefore, a cancer potency factor is not available for oral exposures. A human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

No odor threshold or taste threshold has been established for beryllium. US EPA has established a federal drinking water maximum contaminant level (MCL) of 4 µg/L (ppb) for beryllium. A secondary drinking water standard has not been established.

ATSDR (2002) has established a chronic oral MRL of 0.002 mg/kg-day for beryllium equivalent to the oral reference dose established by EPA IRIS 1998.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 4 µg/L was established under 15A NCAC 02L .0202(c) for beryllium in 2010. This value was based on the federal MCL.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for beryllium is 4 ug/L (ppb) based on the federal Maximum Contaminant Level (MCL).

Uses
Beryllium is a hard, grayish metal naturally found in mineral rocks, coal, soil, and volcanic dust. Beryllium mined from ores is most commonly converted into alloys that are used in electronics, construction materials for machinery, automobiles, computers, sports equipment and dental bridges. Pure, elemental beryllium is used in nuclear weapons and reactors, aircraft and space vehicle structures, x-ray machines and mirrors. Beryllium oxide is used in the manufacture of specialty ceramics for electrical and high-technology applications.

References

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

Morgareidge, K; Cox, GE; Gallo, MA. (1976) Chronic feeding studies with beryllium in dogs. Food and Drug Research Laboratories, Inc. Submitted to the Aluminum Company of America, Alcan Research & Development, Ltd., Kawecki-Berylco Industries, Inc., and Brush-Wellman, Inc.

U.S. EPA Drinking Water Standards and Health Advisories. 2012
. Office of Water (EPA 822-S-12-001) https://www.epa.gov/sites/production/files/2015-09/documents/dwstandards2012.pdf

U.S. EPA Integrated Risk Information System. 1999. IRIS Summary for Beryllium. http://www.epa.gov/iris (accessed June 30, 2016)

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Beryllium CASRN 7440-41-7

North Carolina Groundwater (GW) Standard = 4 µg/L

Summary

The North Carolina GW standard for beryllium and compounds is based on the federal Maximum Contaminant Level (MCL) in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Slight reduction in body weight (lifetime drinking water study in rats).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	2.00E-03	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.1	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**7**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**4**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[9]

5 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 6/30/16). IRIS assessment last revised 4/30/1998. Morgareidge, K; Cox, GE; Gallo, MA. (1976) Chronic feeding studies with beryllium in dogs. Food and Drug Research Laboratories, Inc. Submitted to the Aluminum Company of America, Alcan Research & Development, Ltd., Kawecki-Berylco Industries, Inc., and Brush-Wellman, Inc.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] Beryllium has not been classified by EPA for carcinogenic potential due to inadequate data. A cancer potency factor has not been established.

[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.

[7] MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 6/30/2016). The MCL is based on a slight reduction in body weight reported in a lifetime drinking water study in rats. Schroeder, HA; Mitchener, M. (1975a) Life-term studies in rats: effects of aluminum, barium, beryllium, and tungsten. J Nutr 105:421-427.

[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

[9] PQL provided for informational purposes only. PQL established by North Carolina Water Quality lab (https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/microbiology-inorganics-branch/methods-pqls-qa)

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

May 18, 2010 - Request by DWM to establish IMAC for beryllium.
October 1, 2010 - IMAC of 4 µg/L approved by DWQ Director.

Groundwater Standard Summary Document
Division of Water Resources

COBALT (CASRN 7440-48-4)

Health Effects Summary

Human health effects associated with low environmental exposures to cobalt are unknown. Cobalt is an essential mineral found as cobalamin in Vitamin B_{12}. Cobalt increases erythrocyte levels (necessary for red blood cell production) and hemoglobin and decreases iodine uptake by the thyroid in humans. Ingestion of cobalt has been linked with cardiomyopathy (chronic disease of the heart muscle) in men drinking beer containing cobalt sulfate. It may also trigger dermatitis reactions in persons previously sensitized to cobalt or nickel. In animal studies, ingestion of cobalt-containing compounds produced effects on the heart, liver, kidney, and blood. At high doses, cobalt compounds also produced reproductive and developmental effects.

Data used for Groundwater Standard

US EPA's Integrated Risk Information System (IRIS, 1998) has not established an oral reference dose for cobalt.

The US EPA established a provisional reference dose (p-RfD) of 0.0003 mg/kg-day for cobalt in 2008 (https://hhpprtv.ornl.gov/quickview/pprtv_papers.php). This value was based on reduced iodine update by the thyroid in a 2-week human study. A systemic threshold concentration of 1 ug/L (ppb) can be calculated using the oral reference dose for cobalt in accordance with 15A NCAC 02L .0202(d)(1).

US EPA has not classified cobalt and its compounds for its carcinogenic potential via ingestion. Therefore, a cancer potency factor is not available for oral exposures. A human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

No odor threshold, taste threshold, federal drinking water maximum contaminant level (MCL) or secondary drinking water standard has been established for cobalt.

Recommended Groundwater Standard

An interim maximum allowable concentration (IMAC) of 1µg/L was established under 15A NCAC 02L .0202(c) for cobalt in 2010. This value was based on a p-RfD derived from a 2-week study in humans.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for cobalt is 1 ug/L (ppb) based on the calculated noncancer systemic threshold.

Uses

Cobalt is used in alloys created for high temperature and mechanical stress applications requiring hardness, wear and corrosion resistance. It is also used as a binder for tungsten carbide to increase impact strength. Cobalt is used in pigments for glass, ceramics and paints, as catalysts for hydrotreating/desulfurization in petroleum industry and in Ni/Cd batteries.

Groundwater Standard Summary Document
Division of Water Resources

References

Agency for Toxic Substances and Disease Registry. Toxicological Profile for Cobalt. 2004. http://www.atsdr.cdc.gov/.

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA Drinking Water Standards and Health Advisories. 2012. Office of Water (EPA 822-S-12-001) https://www.epa.gov/sites/production/files/2015-09/documents/dwstandards2012.pdf.

U.S. EPA. Provisional Peer Reviewed Toxicity Values for Cobalt. 2009. Office of Research and Development, National Center for Environmental Assessment https://hhpprtv.ornl.gov/quickview/pprtv_papers.php.

U.S. EPA Integrated Risk Information System. http://www.epa.gov/iris (accessed 7/13/16)

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Cobalt CASRN 7440-48-4

North Carolina Groundwater (GW) Standard = 1 µg/L

Summary

The North Carolina GW standard for cobalt and compounds is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Reversible thyroid toxicity in 2-week human study (reduced iodine uptake).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	3.00E-04	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.1	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**1**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	$(mg/kg\ /day)^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[9]

50 µg/L

References

[1] EPA Provisional Peer Review Toxicity Value for Cobalt. 2008. Roche, M. and Layrisse M. 1956. Effect of cobalt on thyroidal uptake of I131. J. Clin. Endocrinol. Metab. 16:831-833.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] NA; Cobalt has not been classified by EPA for carcinogenic potential. A cancer potency factor has not been established.

[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.

[7] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 7/16/16).

[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.

[9] PQL provided for informational purposes only. PQL established by North Carolina Water Quality lab (https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/microbiology-inorganics-branch/methods-pqls-qa)

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

May 18, 2010 - Request by DWM to establish IMAC for cobalt.
October 1, 2010 - IMAC of 1 µg/L approved by DWQ Director.

Groundwater Standard Summary Document
Division of Water Resources

STRONTIUM (CASRN 7440-24-6)

Health Effects Summary
Human health effects associated with low environmental exposures to strontium are unknown. Strontium accumulates in bone and affects its growth; therefore children are considered a sensitive population with regard to health effects associated with strontium exposures. Abnormal skeletal development (rickets) has been reported in animal studies following dietary exposures to strontium carbonate or chloride.

Data used for Groundwater Standard
US EPA's Integrated Risk Information System (IRIS, 1992) established an oral reference dose (RfD) of 0.6 mg/kg-day for strontium. A systemic threshold concentration of 2100 ug/L (ppb) can be calculated using the oral reference dose for strontium in accordance with 15A NCAC 02L .0202(d)(1).

US EPA has not classified strontium and its compounds for its carcinogenic potential via ingestion. Therefore, a cancer potency factor is not available for oral exposures. A human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

No odor threshold, taste threshold, federal drinking water maximum contaminant level (MCL) or secondary drinking water standard has been established for strontium.

Recommended Groundwater Standard
A groundwater standard of 2,000 µg/L is recommended under 15A NCAC 02L .0202(c) for strontium. This value has been rounded down from the calculated value of 2,100 µg/L in accordance with rounding convention. This value is based on an RfD derived from a NOAEL of 190 mg/kg-day reported in a 20-day feeding study in young rats fed strontium carbonate in their diet. Longer-term term studies with adult rats have reported similar effects at higher doses.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for strontium is 2000 µg/L (ppb) based on the calculated non-cancer systemic threshold.

Uses
Strontium is used in ceramic and glass product manufacturing, aluminum alloys, and ferric magnets. It is also used to impart red color in fireworks.

References
Agency for Toxic Substances and Disease Registry. Toxicological Profile for Strontium. 2004. http://www.atsdr.cdc.gov/

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA Drinking Water Standards and Health Advisories. 2012. Office of Water (EPA 822-S-12-001) https://www.epa.gov/sites/production/files/2015-09/documents/dwstandards2012.pdf

U.S. EPA Integrated Risk Information System. 1992. IRIS Summary for Strontium. http://www.epa.gov/iris (accessed 7/15/16).

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Strontium CASRN 7440-24-6

North Carolina Groundwater (GW) Standard = 2000 µg/L

Summary

The North Carolina GW standard for strontium and compounds is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202. Groundwater standards are established as the least of the criteria in 15A NCAC 02L .0202(d)(1-6) (highlighted in yellow below).
Critical health effect: Bone toxicity (rickets) in young rats (20-day study) with supporting data from longer term studies.

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	6.00E-01	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.1	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**2100**	**µg/L** (rounded to 2000 to account for significant figures)

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[9]

10 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 7/15/16). IRIS assessment last revised 10/1/92. Storey, E. 1961. Strontium "rickets" bone calcium and strontium changes. Austral. Ann. Med. 10: 213-222.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] NA; Strontium has not been classifed by EPA for carcinogenic potential via oral exposures. A cancer potency factor has not been established.

[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.

[7] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 7/16/16).

[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

[9] PQL provided for informational purposes only. PQL established by North Carolina Water Quality lab (https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/microbiology-inorganics-branch/methods-pqls-qa)

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

July 13, 2016 - Request by Division of Water Resources (Animal Feeding Operations and Groundwater Protection Branch) for IMAC for strontium.

Groundwater Standard Summary Document
Division of Water Resources

THALLIUM (CASRN 7440-28-0)

Health Effects Summary

Human health effects associated with low environmental exposures to thallium are unknown. Severe neurological, gastrointestinal, cardiovascular, and respiratory effects leading to death as well as alopecia (hair loss) have been reported in humans and animals following large, acute doses. Changes in blood chemistry, kidney and adrenal weights, and sperm quality in addition to alopecia, developmental delays and increased mortality have been reported in animal studies following oral administration of thallium compounds.

Data used for Groundwater Standard

US EPA's Integrated Risk Information System (IRIS, 1988) established oral reference doses (RfDs) for soluble thallium (I) compounds ranging from 0.00008 to 0.00009 mg/kg-day. The RfDs were withdrawn and replaced with a "qualitative discussion" in 2009 due to the poor quality of the toxicology studies available for thallium.

US EPA's National Center for Environmental Assessment (NCEA, 2012) declined calculating a chronic, oral provisional peer-reviewed toxicity value (PPRTV) due to the lack of good quality toxicology studies available for thallium. They chose instead to derive the following screening levels:

Screening Chronic p-RfD for thallium (I) sulfate	0.00002 mg/kg-day
Screening Chronic p-RfD for soluble thallium	0.00001 mg/kg-day

US EPA determined there are inadequate data to assess the carcinogenic potential of thallium. A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

The ATSDR (1992) declined to establish a chronic MRL for thallium due to a lack of adequate data.

A federal Maximum Contaminant Level (MCL) of 2 µg/L has been established for thallium. This value is based on a 3-month rat study with alopecia as the critical effect.

California established a Public Health Goal (PHG) of 0.1 µg/L and an MCL of 2 µg/L for thallium.

No odor threshold, taste threshold, or secondary drinking water standard has been established for thallium.

Recommended Groundwater Standard

An interim maximum allowable concentration (IMAC) of 0.2 µg/L was established for thallium under 15A NCAC 02L .0202(c) in 2010. This value was based on the EPA IRIS RfD current at that time which has since been withdrawn and replaced with a "qualitative discussion". No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available. The National Toxicology Program (NTP) has proposed additional studies to assess the toxicity of thallium compounds.

The screening levels developed by US EPA NCEA for thallium sulfate and soluble thallium are not appropriate for developing groundwater standards due to the high level of uncertainty associated with such values.

Groundwater Standard Summary Document
Division of Water Resources

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for thallium and its soluble compounds is 2 ug/L (ppb) based on the federal Maximum Contaminant Level (MCL).

Uses

Prior to its ban in the United States in 1972, thallium was used as a rodent and insect pesticide. Thallium is currently used primarily in the semiconductor industry and in the manufacture of optic lenses. When alloyed with mercury, thallium is used in the manufacture of low-melting glass, low-temperature thermometers and switches/closures that operate at subzero temperatures. Its radioisotopes are used in medical procedures for the diagnosis of melanoma and scintography.

References

Agency for Toxic Substances and Disease Registry. Toxicological Profile for Thallium. 1992. http://www.atsdr.cdc.gov/

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

MRI (Midwest Research Institute). 1988. Toxicity of thallium (I) sulfate (CAS NO. 7446-18-6) in Sprague-Dawley rats. Volume 2: Subchronic (90-day) study [revised final report]. Docket ID: EPA-HQ-ORD-2008-0057-0002 and EPA-HQ-ORD-2008-0057-0003.

U.S. EPA Drinking Water Standards and Health Advisories. 2012. Office of Water (EPA 822-S-12-001) https://www.epa.gov/sites/production/files/2015-09/documents/dwstandards2012.pdf

U.S. EPA. Provisional Peer Reviewed Toxicity Values for Thallium and Compounds. 2012. Office of Research and Development, National Center for Environmental Assessment https://hhpprtv.ornl.gov/quickview/pprtv_papers.php.

U.S. EPA Integrated Risk Information System. Chemical Assessment Summary for Thallium (I), soluble salts. 2009. http://www.epa.gov/iris (accessed July 6, 2016).

U.S. EPA Contaminant Information Sheets for the Final CCL 3 Chemicals. 2009. Office of Water (EPA 815-R-09-012). https://www.epa.gov/sites/production/files/2014-05/documents/final-ccl-3-contaminant-information-sheets.pdf

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard

Thallium CASRN 7440-28-0

North Carolina Groundwater (GW) Standard = 2 µg/L

Summary

The North Carolina GW standard for thallium is based on the federal maximum contaminant level (MCL) in accordance with selection criteria defined in 15A NCAC 02L .0202. Groundwater standards are established as the least of the criteria in 15A NCAC 02L .0202(d)(1-6)(highlighted in yellow below).
Critical health effect: Alopecia (hair loss).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	NA	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.2	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**NA**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**2**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[9]

2 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 7/6/16). IRIS assessment last revised 9/30/09. RfDs withdrawn and replaced by "qualitative assessments".

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] NA; EPA has determined there are inadequate data to assess the carcinogenic potential of thallium. A cancer potency factor has not been established.

[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.

[7] MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 7/6/16)

[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

[9] PQL provided for informational purposes only. PQL established by North Carolina Water Quality lab (https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/microbiology-inorganics-branch/methods-pqls-qa)

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

April 27, 2010 - Request by DWM to establish IMAC for thallium.
October 1, 2010 - IMAC of 0.2 µg/L approved by DWQ Director.

Groundwater Standard Summary Document
Division of Water Resources

TIN (INORGANC FORMS) (CASRN 7440-28-0)

Health Effects Summary

Human health effects associated with low environmental exposures to inorganic forms of tin, such as elemental tin, tin (II) chloride, tin (II) fluoride, and tin (IV) oxide, are unknown. However, inorganic forms of tin are generally considered to have low toxicity due to poor absorption, low accumulation in tissues, and rapid excretion. Tin-lined cans are considered the primary source of human exposure. Nausea, abdominal cramps, vomiting, diarrhea, fatigue and headache are the most commonly reported adverse effects reported by humans ingesting food and/or beverages containing tin concentrations exceeding 100 ppm (mg/L or mg/kg). Changes in blood chemistry, reduced body weights, and histopathological findings in the liver and kidney were reported in rats following oral administration of tin (II) chloride.

Data used for Groundwater Standard

U.S. EPA's Integrated Risk Information System (IRIS) has not established an oral reference dose (RfD) for inorganic forms of tin.

U.S. EPA has not established a Provisional Peer Reviewed Toxicity Value (PPRTV) for inorganic forms of tin.

ATSDR established a subchronic MRL of 0.3 mg/kg-day for tin based on a 13-week feeding study in rats with tin (II) chloride (De Groot et al., 1973).

U.S. EPA HEAST (1997) reported a chronic RfD of 0.6 mg/kg-day for tin and compounds based on a two-year rat feeding study with stannous chloride (NTP, 1982). A NOAEL of 2000 ppm tin (II) chloride/kg feed and an uncertainty factor of 100 was used to derive the RfD. Average daily food consumption and animal weights used in the derivation were not reported.

U.S. EPA has not established a Drinking Water Standard or Health Advisory for inorganic forms of tin.

U.S. EPA has not classified inorganic forms of tin for carcinogenicity. A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

No odor threshold, taste threshold, federal maximum contaminant level or secondary drinking water standard has been established for inorganic tin.

A provisional tolerable weekly intake value of 14 mg/kg-week was established by the Joint FAI/WHO Expert Committee on Food Additives (2001).

A systemic threshold concentration of 2000 µg/L (ppb) can be calculated using the oral reference dose cited in HEAST for tin and compounds in accordance with 15A NCAC 02L .0202(d)(1).

Groundwater Standard Summary Document
Division of Water Resources

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 2000 µg/L was established under 15A NCAC 02L .0202(c) for tin in 2010. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for inorganic forms of tin is 2000 ug/L (ppb) based on the rounded down calculated "non-cancer" systemic threshold.

Uses
Inorganic tin is used primarily as lining for food, beverage and aerosol containers. Tin alloys are used in brass, bronze, pewter and soldering materials. Tin oxide is used in the ceramics and glass industries and as a catalyst. Tin chloride (II) is used in tin electroplating and as a food preservative and color-retention agent. Tin (II) fluoride is an anti-caries additive to toothpaste.

References
Agency for Toxic Substances and Disease Registry. Toxicological Profile for Tin and Compounds. 2003. U.S. Department of Health and Human Services, Public Health Service. http://www.atsdr.cdc.gov/

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

Joint FAO/WHO Expert Committee on Food Additives (JECFA). 2001 Safety evaluation of certain food additives and contaminants. Prepared by the 55th meeting of the Joint FAO/WHO Expert Committee on Food Additives. Geneva, World Health Organization (WHO Food Additive Series 46). http://www.inchem.org/documents/jecfa/jecmono/v46je01.htm

NTP. 1982. Technical report series no. 231 on the carcinogenesis bioassay of stannous chloride (CAS No. 7772-99-8) in F344/N rats and B6C3F1/N mice (feed study) Research Triangle Park, NC: National Toxicology Program. U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health. NIH Publication No. 82-1887.

U.S. EPA Drinking Water Standards and Health Advisories. 2012. Office of Water (EPA 822-S-12-001) https://www.epa.gov/sites/production/files/2015-09/documents/dwstandards2012.pdf

U.S. EPA Health Assessment Summary Tables. 1997. Office of Solid Waste and Emergency Response. EPA-540-R-97 036 (PB97-921199)

U.S. EPA. Provisional Peer Reviewed Toxicity Values. Office of Research and Development, National Center for Environmental Assessment https://hhpprtv.ornl.gov/quickview/pprtv_papers.php (accessed July 11, 2016).

U.S. EPA Integrated Risk Information System. http://www.epa.gov/iris (accessed July 11, 2016).

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov

Young WF, Horth H,
Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Tin (Inorganic forms) CASRN 7440-31-5

North Carolina Groundwater (GW) Standard = 2000 µg/L

Summary

The North Carolina GW standard for inorganic forms of tin is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202. Groundwater standards are established as the least of the criteria in 15A NCAC 02L .0202(d)(1-6) (highlighted in yellow below).
Critical health effect: Liver and kidney lesions

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	6.00E-01	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.1	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**2100**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	$(mg/kg\ /day)^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[9]

10 µg/L

References

[1] U.S. EPA HEAST for Tin and Compounds (NTP. 1982. Technical report series no. 231 on the carcinogenesis bioassay of stannous chloride (CAS No. 7772-99-8) in F344/N rats and B6C3F1/N mice (feed study). NIH Publication No. 82-1887)

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] NA; EPA has not classified tin or its organic forms for carcinogenicity. A cancer potency factor has not been established.

[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.

[7] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 7/12/162016)

[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

[9] PQL provided for informational purposes only. PQL established by North Carolina Water Quality lab (https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/microbiology-inorganics-branch/methods-pqls-qa)

NA = Not available

RSC = 0.1 for nonorganics, 0.2 for organics

History

April 27, 2010 - Request by DWQ to establish IMAC for tin.
October 1, 2010 - IMAC of 2000 µg/L approved by DWQ Director.

Groundwater Standard Summary Document
Division of Water Resources

VANADIUM (CAS # 7440-62-2) AND COMPOUNDS (various CAS #s)

Health Effects Summary

Human health effects associated with low environmental exposures to vanadium are unknown. Quadravalent and pentavalent vanadium (V^{+4} and V^{+5}), considered the most toxic oral forms of vanadium, are the forms most commonly found in aquatic environments. Average estimated adult dietary exposures to vanadium range from 10-30 µg/day, excluding supplementation. Ingested vanadium compounds are not well absorbed with more than 95% excreted in the feces.

Vanadyl sulfate mimics insulin and reduces blood glucose. Gastrointestinal effects have been reported in humans ingesting large doses of vanadyl sulfate. In animal studies, oral doses of vanadium compounds have produced mild histopathological changes in the kidney, spleen, and lung of rats, increased blood pressure, changes in blood chemistry, reduced body weight, maternal toxicity, decreased survival, and skeletal malformations and growth delays in offspring.

Data used for Groundwater Standard

Reliable and good quality chronic studies assessing the oral toxicity of vanadium and compounds are lacking. There is little consensus on oral toxicity values for vanadium established by governmental agencies.

The U.S. EPA's Integrated Risk Information System (IRIS, 1988) established an oral reference dose (RfD) of 0.009 mg/kg-day for vanadium pentoxide based on a study in rats identifying decreased cystine in hair as the critical effect (Stokinger et al., 1953). This RfD was deemed unsuitable for calculating a groundwater standard because it is based on a non peer-reviewed study evaluating only growth rate, survival, and hair cystine content. The biological relevance of hair cystine level is unclear.

The U.S. EPA published a chronic oral RfD of 0.005 mg/kg-day for vanadium and compounds in its 2016 Regional Screening Level Table for Contaminants at Superfund Sites. However, this value is based on a recalculation of the 1988 IRIS RfD for vanadium pentoxide and is therefore also considered unsuitable for developing a groundwater standard.

The U.S. EPA established a provisional oral reference dose (p-RfD) of 0.00007 mg/kg-day for vanadium and its soluble inorganic compounds excluding vanadium pentoxide in 2009 (https://hhpprtv.ornl.gov/issue_papers/Vanadium.pdf). This value was based on kidney effects observed in a 6-month subchronic study in male rats (Boscolo et al., 1994). However, the relevance of the reported kidney effects in male rats with regard to potential α_{2u} globulin accumulation mechanisms is unknown. In addition, uncertainties associated with the dose calculation including non-reporting of water consumption and estimation of vanadium content in the diet support consideration of alternative studies for deriving a groundwater standard (US EPA, 2009; US FDA, 2001).

The California Office of Environmental Health Hazard Assessment (OEHHA) established a Notification Level for Vanadium of 50 µg/L in 2000 based on reduced weight and length in offspring reported in animal studies. (https://oehha.ca.gov/water/notification-level/proposed-notification-level-vanadium and http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/notificationlevels/notificationlevels.pdf). It is noted that California used a relative source contribution of 0.6 in the calculation to derive a notification level for soluble vanadium.

ATSDR (2012) determined there were insufficient data to calculate a chronic Maximum Contaminant Level (MCL) for vanadium.

The European Food Safety Authority (EFSA, 2004) declined to establish a tolerable upper intake level for vanadium compounds based on lack of adequate study data.

The U.S. FDA established a Tolerable Upper Intake Level (UL) for adults of 1.8 mg/day for vanadium based on a 3-month subchronic study in rats (Domingo et al., 1986). It is important to note that the derivation of a chronic RfD using a subchronic study underscores the lack of reliable and good quality chronic studies for vanadium.

The U.S. EPA has not classified vanadium pentoxide or soluble vanadium inorganic compounds for carcinogenicity for oral exposures. A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1 x 10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

No odor threshold, taste threshold, federal maximum contaminant level or secondary drinking water standard has been established for vanadium or its compounds.

Recommended Groundwater Standard

An interim maximum allowable concentration (IMAC) of 0.3 µg/L was established under 15A NCAC 02L .0202(c) for vanadium (excluding vanadium pentoxide) in 2010. This value was calculated using the 2009 US EPA provisional RfD of 0.00007 mg/kg-day for soluble inorganic forms of vanadium (excluding vanadium pentoxide).

Further review of the basis for US EPA's RfD for vanadium pentoxide and provisional RfD for soluble inorganic forms of vanadium identified inconsistencies and study deficiencies that support using alternative values for the derivation of a North Carolina groundwater standard. However, reliable and well-reported chronic oral toxicological studies with vanadium and its soluble compounds are lacking.

The recommended groundwater standard for vanadium and compounds is 7 ug/L (ppb). This standard is based on the RfD value of 0.002 mg/kg-day adopted by the California Water Resources Control Board. The RfD was calculated using a LOAEL of 2.1 mg/kg reported in a developmental and reproductive study (Domingo et al., 1986) and an uncertainty factor of 1000 (10 for extrapolation from animals to human, 10 for human variability, and 10 for use of an LOAEL).

Naturally-occurring levels of vanadium in North Carolina may be higher than the calculated groundwater standard.

Table 1. Summary of toxicity values for vanadium

Agency	Date	Critical Animal Study	Critical Endpoint	Vanadium Toxicity Value	Calculated NC GW Standard[a]
ATSDR	2012	Not identified	Not identified	NA	NA
California EPA Water Resources Control Board Notification Level for Vanadium	2000	Domingo et al., 1986	↓ weight and length in offspring	0.002 mg/kg-day	7 µg/L
European Food Safety Association (EFSA)	2004	Not identified	Not identified	NA	NA
US EPA Health Reference Level (HRL) for CCL3 contaminants (vanadium)	2009	Not identified	Minor renal effects (1992 ATSDR subchronic MRL Domingo et al.,1985)	0.003 mg/kg-day	11 µg/L
US EPA IRIS (vanadium pentoxide)	1988	Stokinger et al. 1957,1981	↓ Cystine in hair	0.009 mg/kg-day	32 µg/L
US EPA PPRTV (soluble vanadium compounds excluding vanadium pentoxide)	2009	Boscolo et al. 1994	Kidney toxicity	p-RfD = 0.00007 mg/kg-day	0.3 µg/L
US EPA Regional Screening Levels (vanadium and compounds)	2016	Stokinger et al. 1957,1981	↓ Cystine in hair	0.005 mg/kg-day (calculated value based on vanadium pentoxide RfD)	18 µg/L
US EPA Regional Screening Levels (vanadium pentoxide)	2016	Stokinger et al. 1957,1981	↓ Cystine in hair	0.009 mg/kg-day	32 µg/L
US FDA	2001	Domingo et al. 1985	Histopath findings in kidney, spleen, and lung	Tolerable Upper Intake Level (UL)[b] = 1.8 mg/day (equivalent to 0.026 mg/kg-day)	90 µg/L

[a] Relative source contribution = 0.1 for inorganics in accordance with 15A NCAC 02L .0202.
[b] UL calculated for adults as insufficient information available for pregnant women and children.

Uses

Vanadium alloys are used primarily as stabilizing, strengthening, and anti-corrosive agents in steel manufacturing. Oxides of vanadium (ammonium metavanadate, vanadium pentoxide, sodium vanadate, and vanadyl sulfate) are used in the paint/ceramic industry to impart yellow and blue color. Vanadium is also used as an industrial catalyst and in the manufacture of sulfuric acid.

Vanadyl sulfate and sodium metavanadate are used as nutritional and bodybuilding supplements. Vanadyl sulfate has been used in human and animal research studies investigating the insulin reducing effects of vanadium.

Groundwater Standard Summary Document
Division of Water Resources

References

Agency for Toxic Substances and Disease Registry. 2012. Toxicological Profile for Vanadium. http://www.atsdr.cdc.gov/ https://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=276&tid=50

Amoore, J.E. and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

Boscolo, P., M. Carmignani, G. Del Rosso et al. 1994. Renal toxicity and arterial hypertension in rats chronically exposed to vanadate. Occup. Env. Med. 51:500–503.

California Water Resources Control Board, Drinking Water Notification Levels (accessed Sept 18, 2017) 2016) http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/notificationlevels/notificationlevels.pdf

Domingo, J.L., J.L. Llobet, J.M. Tomas et al. 1985. Short-term toxicity studies of vanadium in rats. J. Appl. Toxicol. 5:418–421.

Domingo, J.L., Paternain J.L., Llobet J.M., and Corbella J. 1986. Effects of vanadium on reproduction, gestation, parturition, and lactation in rats upon oral administration. Life Sciences. 39(9): 819-824.

European Food Safety Authority. 2004. Opinion of the scientific panel on dietetic products, nutrition and allergies on a request from the commission related to the tolerable daily intake level of vanadium. The EFSA Journal, 33:1-22.

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U.S. EPA. Drinking Water Standards and Health Advisories. 2012. Office of Water (EPA 822-S-12-001) https://www.epa.gov/sites/production/files/2015-09/documents/dwstandards2012.pdf

U.S. EPA Integrated Risk Information System. 1988. Chemical Assessment Summary for Vanadium Pentoxide https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=125 and http://www.epa.gov/iris (accessed September 18, 2017)

U.S. EPA Provisional Peer Reviewed Toxicity Values (PPRTV) for Vanadium and its Soluble Inorganic Compounds other than Vanadium Pentoxide. 2009. Office of Research and Development, National Center for Environmental Assessment https://hhpprtv.ornl.gov/issue_papers/Vanadium.pdf and https://hhpprtv.ornl.gov/quickview/pprtv_papers.php

U.S. FDA Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc. 2001. National Academy of Sciences, pp. 532-553.
https://www.nal.usda.gov/sites/default/files/fnic_uploads//vitamin_a_full_report.pdf

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

North Carolina Groundwater Standard Calculation Sheet

Vanadium CASRN 7440-62-2

North Carolina Groundwater (GW) Standard = 7 µg/L

Summary

The North Carolina GW standard for vanadium and compounds is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202. Groundwater standards are established as the least of the criteria in 15A NCAC 02L .0202(d)(1-6) (highlighted in yellow below).
Critical health effect: Reduced weight and length in rat offspring.

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	2.0E-03	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.1	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**7**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	$(mg/kg\ /day)^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Additonal Information

FDA Tolerable Upper Intake Level[9]	**1,800**	**µg/day**
California Water Board Notification Level[10]	**50**	**µg/L**

Practical Quantitation Limit (PQL)[11] 10 µg/L

References

[1] California Water Resources Control Board, Drinking Water Notification Levels (accessed 9/18/2017) https://oehha.ca.gov/water/notification-level/proposed-notification-level-vanadium /www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/notificationlevels/notificationlevels.pdf. Based on Domingo, J.L., Paternain J.L., Llobet J.M., and Corbella J. 1986. Effects of vanadium on reproduction, gestation, partiturition, and lactation in rats upon oral administration. Life Sciences. 39(9): 819-824.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] NA; Vanadium and its compounds have not been classified for carcinogenicity. A cancer potency factor has not been established.

[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.

[7] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 7/6/16)

[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

[9] U.S. FDA Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc. 2001. National Academy of Sciences, pp. 532-553. https://www.nal.usda.gov/sites/default/files/fnic_uploads//vitamin_a_full_report.pdf

[10] California Water Resources Control Board, Drinking Water Notification Levels (accessed Sept 18, 2017) 2016) http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/notificationlevels/notificationlevels.pdf

[11] PQL provided for informational purposes only. PQL established by North Carolina Water Quality lab (https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/microbiology-inorganics-branch/methods-pqls-qa)

NA = Not available

RSC = 0.1 for nonorganics, 0.2 for organics

History

April/June 2010 - Request by DWM to establish NC IMAC for vanadium.
October 1, 2010 - IMAC of 0.3 µg/L approved by DWQ Director.

Groundwater Standard Summary Document
Division of Water Resources

ACROLEIN (107-02-8)

Health Effects Summary
Human health effects associated with ingestion of low environmental concentrations of acrolein are unknown. Acrolein vapor and liquid causes irritation of mucous membranes. No significant toxic effects were reported in rats administered aqueous solutions of acrolein via gavage for 13-weeks. Decreased survival rates were observed in mice and rats following oral administration of aqueous acrolein solutions for two years at the highest doses tested. However, except for decreased creatinine kinase levels, no significant clinical or histopathological effects were reported.

Data used for Groundwater Standard
USEPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.00005 mg/kg-day for acrolein based on decreased survival in a 2-year rat study. A systemic threshold concentration of 4 µg/L (ppb) can be calculated using the oral reference dose for acrolein in accordance with 15A NCAC 02L .0202(d)(1).

US EPA has characterized the data for acrolein as "inadequate for the assessment of human carcinogenic potential for either the oral or inhalation route" according to their revised draft Guidelines for Carcinogen Risk Assessment (1999). Therefore, a cancer potency factor is not available. A human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

An odor threshold of 110µg/L has been established for acrolein in water (Amoore et al., 1983). No taste threshold, federal maximum contaminant level or secondary drinking water standard has been established for this chemical.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 4 µg/L was established under 15A NCAC 02L .0202(c) for acrolein in 2010. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for acrolein is 4 ug/L (ppb) based on the calculated noncancer systemic threshold.

Uses
Acrolein is used as an herbicide, a slimicide in paper manufacture, and an algal and underwater plant inhibitor in cooling water towers and water treatment ponds. It is also used in the synthesis of acrylic acid and DL-methionine (an amino acid).

References
Agency for Toxic Substances and Disease Registry. Toxicological Profile for Acrolein. 2007. http://www.atsdr.cdc.gov/

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA. Provisional Peer Reviewed Toxicity Values for Acrolein. 2002. Office of Research and Development, National Center for Environmental Assessment https://hhpprtv.ornl.gov/quickview/pprtv_papers.php

U.S. EPA. 2003. Integrated Risk Information System. Toxicological Review of Acrolein. http://www.epa.gov/iris (accessed May 27, 2016). EPA/635/R-03/003

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U.S. EPA Pesticide Reregistration Eligibility Decision. 2008. List B, Case 2005. https://archive.epa.gov/pesticides/reregistration/web/html/status.html

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Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Acrolein CASRN 107-02-8

North Carolina Groundwater (GW) Standard = 4 µg/L

Summary The North Carolina Ground Water Standard for acrolein is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).

Critical health effect: Decreased survival (2-year rat study).

GW Standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	5.00E-04	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.2	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**4**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**110**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL[9])

5 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed May 27, 2016). IRIS assessment last revised 6/3/2003. Parent, RA; Caravello, HE; Long, JE. (1992a) Two-year toxicity and carcinogenicity study of acrolein in rats. J Appl Toxicol 12(2):131-139.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] NA; Acrolein has not been classified for carcinigenicity by US EPA or IARC due to inaqequate experimental data. A cancer potency factor has not been established.

[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[6] Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

[7] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 5/27/2016)

[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

[9] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. New Jersey reports a PQL for acrolein measured in groundwater (http://www.nj.gov/dep/wms/bears/Appendix_Table_1.htm)

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

April/June 2010 - NC Division of Waste Management requested IMAC for acrolein.
October 1, 2010 - IMAC of 4 µg/L approved by DWQ Director.

Groundwater Standard Summary Document
Division of Water Resources

ALACHLOR (15972-60-8)

Health Effects Summary
Human health effects associated with low environmental exposures to alachlor are unknown. Systemic effects were observed in the kidneys, spleens and livers of dogs exposed to alachlor for 1-year.
Treatment-related nasal, stomach, and thyroid tumors were reported in two-year feeding studies in rats while broncheoalveolar adenomas and carcinomas were observed in 2-year mouse studies. Carcinogenic effects were observed at doses several fold larger than doses used in the chronic studies.

Data used for Groundwater Standard
US EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.01 mg/kg-day for alachlor based on hemosiderosis (iron accumulation) in the kidney, liver, and spleen and hemolytic anemia (destruction of red blood cells) in the liver observed in a one-year feeding study in male dogs. (https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0129_summary.pdf)
A systemic threshold concentration of 70 ug/L (ppb) can be calculated using the oral reference dose for alachlor in accordance with 15A NCAC 02L .0202(d)(1).

US EPA classified alachlor as "likely" to be carcinogenic to humans at high doses but "not likely" at low doses according to EPA's proposed Guidelines for Cancer Risk Assessment (1996). The cancer slope factor used to calculate the 2010 IMAC has been withdrawn by EPA based on their re-evaluation and reclassification of alachlor carcinogenicity as a threshold effect. Therefore, a cancer potency factor is not available. A human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

No odor threshold or taste threshold has been established for alachlor. US EPA has established a federal drinking water maximum contaminant level (MCL) of 2 µg/L (ppb) for alachlor. A secondary drinking water standard has not been established.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 0.4 µg/L was established under 15A NCAC 02L .0202(c) for alachlor in 2010. This concentration was derived using a cancer potency factor that is no longer supported by EPA.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for alachlor is 2 ug/L (ppb) based on the federal maximum drinking water level (MCL).

Uses:
Alachlor is an herbicide used for control of annual grasses and broadleaf weeds in crops, primarily corn, sorghum, soybeans, peanuts, and beans. Products containing alachlor are classified as "restricted use" herbicides because of concern about groundwater contamination.

Groundwater Standard Summary Document
Division of Water Resources

References

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA Drinking Water Standards and Health Advisories. 2012. Office of Water (EPA 822-S-12-001) https://www.epa.gov/sites/production/files/2015-09/documents/dwstandards2012.pdf

U.S. EPA Integrated Risk Information System. 1993. IRIS Summary for Alachlor. http://www.epa.gov/iris (accessed June 3, 2016)

U.S. EPA Pesticide Reregistration Status https://archive.epa.gov/pesticides/reregistration/web/html/status.html

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Alachlor CASRN 15972-60-8

North Carolina Groundwater (GW) Standard **2 µg/L**

Summary The North Carolina GW standard for alachlor is based on the federal maximum contaminant level (MCL) in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Liver and blood toxicity effects in dogs (1-year study).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	1.00E-02	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.2	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**70**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**2**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL[9]) 4 **µg/L**

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 6/3/16). IRIS assessment last revised 9/1/93. Monsanto Company. 1984. MRID No. 00148923; HED Doc No. 004660.
[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).
[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).
[4] NA; Alachlor has been classified by EPA as "likely" to be a human carcinogen at high doses, but "not likely" at low doses in accordance with the EPA proposed Guidelines for Carcinogen Risk Assessment (April 23, 1996). EPA determined that a non-linear margin of exposure (MOE) approach should be used for risk assessment rather than the q1* approach. EPA has withdrawn its calculated cancer potency factor for alachlor.
[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.
[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.
[7] MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 6/6/2016).
[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.
[9] PQL established by North Carolina Water Quality lab. (ps://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/organic-chemistry- branch/methods-pqls-organics).

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

February 10, 2010 - Division of Waste Management requested IMAC for alachlor.
August 1, 2010 - IMAC of 0.4 µg/L approved by DWQ Director.

Groundwater Standard Summary Document
Division of Water Resources

ALDRIN (300-00-2)

Health Effects Summary
Human health effects associated with low environmental exposures to aldrin are unknown. Chronic feeding studies in rats and mice reported neurological effects. Liver lesions were reported following chronic exposures in rats and dogs. Administration of aldrin to mice for two years via the diet produced malignant liver tumors; however, no carcinogenic effects were reported in rats under similar experimental conditions. Increased pup mortality, decreased mammary development and milk production was reported in reproductive /developmental studies in dogs. Increased pup mortality, decreased fertility, and malformations including webbed feet, cleft palate, and open eyes were observed in similar studies with rodents.

Data used for Groundwater Standard
US EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.00003 mg/kg-day for aldrin based on liver lesions in rats and mice (Fitzhugh et al., 1964). A chronic, human drinking water exposure concentration of 0.2 ug/L (ppb) can be calculated using the oral reference dose for aldrin in accordance with 15A NCAC 02L .0202(d)(1).

US EPA classified aldrin as a probable human carcinogen according to the 1986 US EPA Cancer Guidelines (Category B2- sufficient evidence in animals and inadequate or no evidence in humans). US EPA established a cancer potency factor of 17 mg/kg/day for aldrin based on malignant liver tumors observed in long-term studies in mice (US EPA, 1988). A chronic, human drinking water exposure concentration of 0.002 µg/L associated with an incremental lifetime cancer risk estimate of 1×10^{-6} can be calculated using these data according to the requirements of 15A NCAC 02L .0202(d)(2).

No odor threshold, taste threshold, federal maximum contaminant level or secondary drinking water standard has been established for this chemical.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 0.002 µg/L was established under 15A NCAC 02L .0202(c) for aldrin in 2010. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for aldrin is 0.002 ug/L (ppb) based on the chronic, drinking water concentration corresponding to an incremental lifetime cancer risk of 1×10^{-6}.

Uses:
Aldrin is an organochlorine pesticide used historically as a soil insecticide. It was used predominantly on corn and citrus to protect against termites, corn rootworms, seed corn beetles and maggots, wireworms, rice water weevil, grasshoppers, Japanese beetles and to prevent ant and termite infestation in wooden structures. Production of aldrin was halted in the United States in 1974; importation ceased in 1987.
Aldrin degrades in environmental matrices to form dieldrin (CAS # 60-57-1).

Groundwater Standard Summary Document
Division of Water Resources

References

Fitzhugh, O.G., A.A. Nelson, and M.L. Quaife. 1964. Chronic oral toxicity of aldrin and dieldrin in rats and dogs. Food Cosmet. Toxicol. 2: 551-562.

Agency for Toxic Substances and Disease Registry. Toxicological Profile for Aldrin/Dieldrin. 2002. http://www.atsdr.cdc.gov/.

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA. 1988. Project Summary: Carcinogenicity Assessment of Aldrin and Dieldrin. Prepared by the Office of Health and Environmental Assessment, Carcinogen Assessment Group, Washington, DC, for the Hazard Evaluation Division, Office of Pesticides and Toxic Substances, Office of Pesticide Programs, Washington, DC. ((EPA/600/S6-87/006).

U.S. EPA Drinking Water Standards and Health Advisories. 2012. Office of Water (EPA 822-S-12-001) https://www.epa.gov/sites/production/files/2015-09/documents/dwstandards2012.pdf

U.S. EPA. Provisional Peer Reviewed Toxicity Values for Aldrin. 2005. Office of Research and Development, National Center for Environmental Assessment https://hhpprtv.ornl.gov/quickview/pprtv_papers.php

U.S. EPA Integrated Risk Information System. 1987. IRIS Summary for Aldrin. http://www.epa.gov/iris (accessed June 6, 2016)

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Aldrin CASRN 309-00-2

North Carolina Groundwater (GW) Standard = 0.002 µg/L

Summary The North Carolina GW standard for aldrin is based on a cancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Malignant liver tumors in mice (2-year feeding study).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	3.00E-05	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.2	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**0.2**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	17	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**0.002**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL[9]) 0.03 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 6/6/16). IRIS assessment last revised 9/30/87. Davis, K.J. and O.G. Fitzhugh. 1962. Tumorigenic potential of aldrin and dieldrin for mice. Toxicol. Appl. Pharmacol. 4: 187-189.
[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).
[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).
[4] Aldrin has been classified by EPA as a probable human carcinogen according to the 1986 US EPA Cancer Guidelines (Category B2- sufficient evidence in animals and inadequate or no evidence in humans).
[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.
[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.
[7] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 6/6/2016).
[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.
[9] PQL established by North Carolina Water Quality lab. (ps://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/organic-chemistry- branch/methods-pqls-organics).

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

April/June 2010 - Division of Waste Management (DWM) requested IMAC for aldrin. October 1, 2010 - IMAC of 0.002 µg/L approved by DWQ Director.

Groundwater Standard Summary Document
Division of Water Resources

DICHLOROACETIC ACID (CASRN 79-43-6)

Health Effects Summary
Human health effects associated with low environmental exposures to dichloroacetic acid are unknown. Therapeutic doses of ≥ 10 mg dichloroacetic acid /kg-day used to treat human metabolic diseases have produced neurotoxic effects.

Dogs exposed to dichloroacetic acid in capsule form for 90-days exhibited lesions in the testes, liver and brain at the lowest dose tested of 12.5 mg/kg-day. Kidney, lung, and pancreatic lesions were also observed. At higher doses, reduced body weight, body weight gain, ocular effects, partial paralysis of the hind legs, and mortality as a result of severe dehydration was reported. Testicular toxicity has been reported in additional dog and rodent studies.

Exposure to dichloracetic acid via drinking water in long-term studies (1-2 years) produced dose-related increases in liver tumors in male and female mice and male rats.

Data used for Groundwater Standards
U.S. EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.004 mg/kg-day for dichloroacetic acid based on lesions of the testes, liver, and brain reported in a 90-day oral dog study. A threshold concentration of 28 µg/L can be calculated using the oral reference dose for dichloroacetic acid in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA has classified dichloroacetic acid as likely to be carcinogenic to humans in accordance with the 2005 U.S. EPA Cancer Guidelines. A cancer slope factor of 0.05 per mg/kg-day was calculated using the Benchmark Dose Multistage Model and mouse liver tumor incidence data. A human exposure concentration of 0.7 µg/L associated with an incremental lifetime cancer risk estimate of 1 x 10^{-6} can be calculated in accordance with the requirements of 15A NCAC 02L .0202(d)(2).

No aqueous odor threshold, aqueous taste threshold or secondary drinking water standard has been established for dichloracetic acid. A federal maximum contaminant level (MCL) of 60 µg/L has been established as the total maximum concentration for five haloacetic acids (monochloro acetic acid, dichloroacetic acid, trichloroacetic acid, monobromo acetic acid, and dibromo acetic acid)

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 0.7 µg/L was established under 15A NCAC 02L .0202(c) for dichloracetic acid in 2010. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for dichloroacetic acid is 0.7 ug/L (ppb) based on the chronic drinking water concentration corresponding to an incremental lifetime cancer risk of 1 x 10^{-6}.

Uses
Dichloroacetic acid is used therapeutically in humans to treat metabolic disorders including congenital lactic acidosis. It is also used as a test reagent for analytical measurements during fiber manufacture and as a substitute medicinal disinfectant for formalin. Esters of dichloroacetic acid are used in the synthetic

production of glyoxylic acid, dialkoxy and diaroxy acids and sulfonamindes used to produce iron chelates for the agriculture sector.

References

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

Cicmanec JL, and Wang SR.1991. 90-day toxicity study of dichloroacetate in dogs. *Fundamental and Applied Toxicology*, 17(2): 376–389.

DeAngelo AB, Daniel, FB, Stober JA, and Olson GR. 1991. The carcinogenicity of dichloroacetic acid in the male B6C3F1 mouse. *Fundamental and Applied Toxicology*, 16: 337–347.

DeAngelo AB, Daniel, FB, Stober JA, and Olson GR. 1996. The carcinogenicity of dichloroacetic acid in the male Fischer 344 rat. *Toxicology*, 114: 207–221.

DeAngelo AB, George MH, House DE. 1999. Hepatocarcinogenicity in the male B6C3F1 mouse following a lifetime exposure to dichloroacetic acid in the drinking water: dose–response determination and modes of action. *Journal of Toxicology and Environmental Health*, 58(8): 485–507.

U.S. EPA Drinking Water Standards and Health Advisories. 2012. Office of Water (EPA 822-S-12-001) https://www.epa.gov/sites/production/files/2015-09/documents/dwstandards2012.pdf

U.S. EPA Integrated Risk Information System. 2003. Chemical Assessment Summary for Dichloroacetic Acid. http://www.epa.gov/iris (accessed October 6, 2016).

U.S. EPA Drinking Water Addendum to the IRIS Toxicological Review of Dichloroacetic Acid. November 2005. (EPA Document Number 822-R-05-009)

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

World Health Organization Dichloroacetic Acid in Drinking Water (Background document for development of WHO Guidelines for Drinking-water Quality). 2005. Geneva, World Health Organization (Document Number WHO/SDE/WSH/05.08/121)

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Dichloroacetic acid CASRN 79-43-6

North Carolina Groundwater (GW) Standard = 0.7 µg/L

Summary The North Carolina GW standard for dichloroacetic acid is based on a cancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Liver cancer in mice (2-year drinking water study).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	4.0E-03	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	unitless value
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**28**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	0.05	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**0.7**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**NA**	**µg/L**
Odor Threshold[7]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**60**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[10] 1 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 10/5/16). IRIS assessment last revised 9/11/03. Cicmanec, J.L., L.W. Condie, G.R. Olson and S.R. Wang. 1991. 90-Day toxicity study of dichloroacetate in dogs. Fundam. Applied Toxicol. 17(2):376-89.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[5] US EPA has classified dichloroacetic acid as likely to be carcinogenic to humans according to the 2005 US EPA Cancer Guidelines. An oral cancer slope factor of 0.05 per mg/kg-day has been established using the Benchmark Dose Multistage Model. DeAngelo, A.B., M.H. George and D.E. House. 1999. Hepatocarcinogenicity in the male B6C3F1 mouse following a lifetime exposure to dichloroacetic acid in the drinking water: dose-response determination and modes of action. J. Toxicol. Environ Health. 58(8):485-507. [6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[7] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.

[8] MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic. MCL for TOTAL concentration of five haloacetic acids (of which dichloroacetic acid is one) is 60 µg/L (accessed 10/6/16).

[9] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.

[10] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. US EPA Method 552.3 detects haloacetic acids, including dichloroacetic acid, in drinking water. Canada Drinking Water Guidelines for Haloacetic Acids reports a PQL for dichloracetic acid of 0.2 µg/L using EPA Method 552.3 (Table 6). http://healthycanadians.gc.ca/publications/healthy-living-vie-saine/water-haloacetic-haloacetique-eau/index-eng.php

NA = Not available

History

April 27, 2010 - Division of Waste Management requested IMAC dichloroacetic acid. October 1, 2010 - IMAC of 0.7 µg/L approved by DWQ Director.

Groundwater Standard Summary Document
Division of Water Resources

2, 4-DICHLOROPHENOL (CASRN 120-83-2)

Health Effects Summary

Human health effects associated with low environmental exposures to 2, 4-dichlorophenol are unknown. Mice exposed to 2, 4-dichlorophenol in drinking water and diet for 3-6 months have exhibited inconsistent changes in blood and clinical chemistry parameters and one report of hyperplasia of hepatic cells at the highest dose tested. No significant reproductive effects were reported in mice exposed to 2, 4- dichlorophenol in drinking water for 90-days. Increased liver and spleen weights and cell-mediated immunity was reported in a 147-day rat drinking water study. No carcinogenic effects were reported in a 2-year National Toxicology Program Study dietary study with rats and mice.

Data used for Groundwater Standards

U.S. EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.003 mg/kg-day for 2, 4-dichlorophenol based on decreased delayed hypersensitivity response in a 90-day drinking water study in rats. A threshold concentration of 21 µg/L can be calculated using the oral reference dose for 2, 4-dichlorophenol in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA has not classified 2, 4-dichlorophenol for carcinogenicity. A cancer slope factor is not available and a lifetime cancer risk estimate of 1×10^{-6} cannot be calculated in accordance with the requirements of 15A NCAC 02L .0202(d)(2). It is noted that the National Toxicology Program (NTP) evaluated 2,4- dichlorophenol in a 2-year feeding study in mice and rats. No evidence of carcinogenic effects was reported for either species.

An aqueous odor and taste threshold of 1.4 µg/L and 0.98 µg/L, respectively, have been reported for 2,4- dichlorophenol (Young et al., 1996; Czerny et al., 2008). A federal maximum contaminant level (MCL) or secondary drinking water standard has not been established for 2, 4-dichlorphenol.

Recommended Groundwater Standard

An interim maximum allowable concentration (IMAC) of 0.98 µg/L was established under 15A NCAC 02L .0202(c) for 2, 4-dichlorophenol in 2010. A more recent aqueous odor threshold has been published (Czerny et al., 2008). However, because its value is greater than the published taste threshold, it does not influence the selection of the North Carolina groundwater standard for 2, 4-dichlorophenol.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for 2, 4-dichlorophenol is 0.98 ug/L (ppb) based on its aqueous taste threshold.

Uses

2, 4-Dichlorophenol is used primarily as an intermediate in the industrial manufacture of the herbicide, 2, 4–dichlorophenoxyacetic acid (2,4-D). It is also used as a mothproofing agent, germicide, and antiseptic. It is also produced as a byproduct of water disinfection processes.

References

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

Czerny M, Christlbauer M, Christlbauer M, Fisher A, Granvogl M, Hammer M, Hartl C, Hernandez NM, and Schieberle P. 2008. Re-investigation on odour thresholds of key food aroma compounds and development of an aroma language based on odour qualities of defined aqueous odorant solutions. European Food Research Technology, 228:265-273.

Exon, JH and LD Koller. 1985. Toxicity of 2-chlorophenol, 2, 4- dichlorophenol and 2,4,6-trichlorophenol. In: Water Chlorination: Chemistry, Environmental Impact and Health Effects, Jolley et al., Ed., Vol.5. (Chap. 25). Lewis Publishers, Chelsea, MI. p. 307-330.

National Toxicology Program. Toxicology and carcinogenesis studies of 2, 4-dichlorophenol in F344/N rats and B6C3F1 mice. Research Triangle Park, NC, 1989 (NTPTR- 353).

U.S. EPA Drinking Water Standards and Health Advisories. 2012. Office of Water (EPA 822-S-12-001) https://www.epa.gov/sites/production/files/2015-09/documents/dwstandards2012.pdf

U.S. EPA Integrated Risk Information System. 2003. Chemical Assessment Summary for 2, 4- Dichlorophenol. http://www.epa.gov/iris (accessed October 10, 2016).

U.S. EPA Update of Human Health Ambient Water Quality Criteria: 2,4-Dichlorophenol. Office of Water, Office of Science and Technology. (EPA 820-R-15-084)

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

World Health Organization: Chlorophenols in Drinking Water (Background document for development of WHO Guidelines for Drinking-water Quality). 2003. Geneva, World Health Organization (Document Number WHO/SDE/WSH/03.04/47)

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

2,4-Dichlorophenol CASRN 120-83-2

North Carolina Groundwater (GW) Standard = 0.98 µg/L

Summary The North Carolina GW standard for 2,4-dichlorophenol is based on it aqueous taste threshold in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Aqueous taste threshold (not health-based).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	3.0E-03	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	unitless value
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**21**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	NA	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**0.98**	**µg/L**
Odor Threshold[7]	**1.4**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[10] 10 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 10/10/16). IRIS assessment last revised 1/31/87. Exon, J.H. and L.D. Koller. 1985. Toxicity of 2- chlorophenol, 2,4- dichlorophenol and 2,4,6-trichlorophenol. In: Water Chlorination: Chemistry, Environmental Impact and Health Effects, Jolley et al., Ed., Vol.5. (Chap. 25). Lewis Publishers, Chelsea, MI. p. 307-330.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[5] NA; US EPA has not classified 2,4-dichlorophenol for carcinogenicity. A cancer slope factor is not available.

[6] Young WF, Horth H, Crane R, Ogden T and Arnottt M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

[7] Czerny M, Christlbauer M, Christlbauer M, Fisher A, Granvogl M, Hammer M, Hartl C, Hernandez NM, and Schieberle P. 2008. Re-investigation on odour thresholds of key food aroma compounds and development of an aroma language based on odour qualities of defined aqueous odorant solutions. European Food Research Technology, 228:265-273.

[8] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 10/10/16).

[9] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.

[10] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. South Carolina reports a PQL of 10 µg/L for 2,4- dichlorophenol. (https://www.scdhec.gov/environment/docs/npdes_PQL.pdf).

NA = Not available

History

February 10, 2010 - Division of Waste Management requested IMAC for 2,4-dichlorophenol.
August 1, 2010 - IMAC of 0.98 µg/L approved by DWQ Director.

Groundwater Standard Summary Document
Division of Water Resources

2,4-DINITROTOLUENE (CASRN 121-14-2)
2,6-DINITROTOLUENE (CASRN 606-20-2)

Health Effects Summary

Human health effects associated with low environmental exposures to 2,4-dinitrotoluene and 2,6-dinitrotoluene are unknown. Both isomers may be absorbed through the skin. In humans, long-term occupational inhalation exposures to 2,4-dinitrotoluene have caused adverse effects to the central nervous system (CNS), heart, circulatory system, and liver. Oral administration of 2,4-dinitrotoluene and 2,6- dinitrotoluene to animals has produced adverse neurological, blood, reproductive, liver, and kidney effects. Cancer of the kidney, liver, and mammary glands has been reported in animals following long- term oral exposure to 2,4-dinitrotoluene, 2,6-dinitrotoluene and mixtures of nitrotoluenes.

Data used for Groundwater Standard

U.S. EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.002 mg/kg-day for 2,4-dinitrotoluene based on neurotoxic effects (manifested as incoordination and paralysis), the presence of Heinz bodies (damaged hemoglobin within red blood cells), and biliary tract hyperplasia (increased cell production) in a 2-year dog feeding study (U.S. EPA, 1992; Ellis et al., 1979, https://www.epa.gov/iris). A systemic threshold concentration of 14 ug/L (ppb) can be calculated using the oral reference dose for 2,4-dinitrotoluene in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA established a Provisional Peer-Reviewed Toxicity Value (PPRTV) of 0.001 mg/kg-day as a provisional chronic oral RfD for 2,6-dinitrotoluene. This value was based on a NOAEL of 4 mg/kg-day reported from a 13-week oral-dosing dog study in which decreased body weight, neurological, hematological, and liver histopathological effects were reported (U.S. EPA, 2004; Lee et al., 1976, https://hhpprtv.ornl.gov/quickview/pprtv_papers.php). A systemic threshold concentration of 7 ug/L (ppb) can be calculated using the provisional oral reference dose for 2,6-dinitrotoluene in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA has classified the technical grade mixture of 2,4-dinitrotoluene and 2,6-dinitrotoluene isomers as B2 (probable human carcinogen based on sufficient evidence in animals and inadequate evidence in humans). EPA has classified 2,4-dinitrotoluene and 2,6-dinitrotoluene individually as likely to be carcinogenic to humans as referenced in the 2012 EPA Drinking Water Standards and Health Advisories.

U.S. EPA IRIS has calculated a cancer potency factor of 0.68 $(mg/kg\text{-}day)^{-1}$ for the isomeric mixture of 2,4-dinitrotoluene and 2,6-dinitrotoluene. A human exposure concentration of 0.05 µg/L associated with an incremental lifetime cancer risk estimate of 1×10^{-6} can be calculated for each isomer according to the requirements of 15A NCAC 02L .0202(d)(2).

Note: Experimental studies with 2,4-dinitrotoluene have included concurrent exposures to its isomers, including 2,6-dinitrotoluene. Studies evaluating the toxicological effects of pure (100%) individual isomers are not available. While U.S. EPA and Cal EPA have derived cancer slope factors for 2,4-dinitrotoluene, it is difficult to discern the isomeric contribution to the toxicological effects reported. It is recognized that there are uncertainties associated with the cancer slope factors available for dinitrotoluene isomers and mixtures. North Carolina has selected the cancer slope factor derived by U.S EPA (IRIS, 1990) and applied it for 2,4-dinitrotoluene and 2,6-dinitrotoluene based on EPA values

reported in the 2012 Drinking Water Standards and Health Advisories Table. Other states, including Florida and Wisconsin have also used the same cancer slope factor for the individual isomers and the mixture (EPA Technical Fact Sheet, 2014).

No aqueous odor threshold, aqueous taste threshold, federal maximum contaminant level (MCL) or secondary drinking water standard are available for 2,4-dinitrotoluene or 2,6-dinitrotoluene.

Recommended Groundwater Standard

An interim maximum allowable concentration (IMAC) of 0.1 µg/L was established under 15A NCAC 02L .0202(c) for 2,4-dinitrotoluene in 2011. This value was based on a cancer slope factor of 0.31 $(mg/kg\text{-}day)^{-1}$ derived by Cal OEHHA. U.S. The Cal OEHHA cancer slope factor was derived from the EPA cancer slope factor.

EPA calculated a cancer slope factor of 0.68 $(mg/kg\text{-}day)^{-1}$ for a mixture of 2,4-dinitrotoluene and 2,6- dinitrotoluene based on combined mammary and liver tumors reported in female rats in a long-term feeding study (Ellis et al., 1979). U.S. EPA equates the cancer slope factors for the individual isomers and the mixture. Since it is likely that 2,4-dinitrotoluene will co-exist with 2,6-dinitrotoluene, the slope factor derived by U.S EPA is used to derive a groundwater standard.

Chemical	Cancer Slope Factor (CSF)	Endpoint Modeled	CSF Reference
2,4-dinitrotoluene	0.31	Combined mammary and liver tumors (female rats)	Cal OEHHA, 2009
2,6-dinitrotoluene	Not derived	Not derived	US EPA PPRTV, 2004
98% 2,4 isomer, 2% 2,6-isomer mixture	0.68	Combined mammary and liver tumors (female rats)	US EPA IRIS, 1990
DNT Technical grade 76% 2,4 isomer, 19% 2,6 isomer, 5% other isomers	0.45 (provisional screening value)	Combined mammary and liver tumors, liver nodules, and subcutaneous fibromas (male rats)	US EPA PPRTV, 2013

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for 2,4-dinitrotoluene is 0.05 ug/L (ppb) based on the chronic drinking water concentration corresponding to an incremental lifetime cancer risk of 1×10^{-6}.

The recommended groundwater standard for 2,6-dinitrotoluene is 0.05 ug/L (ppb) based on the chronic drinking water concentration corresponding to an incremental lifetime cancer risk of 1×10^{-6}.

Groundwater Standard Summary Document
Division of Water Resources

Uses:
Mixtures of dinitrotoluenes (DNT) are formed from the reaction of nitric acid and toluene with 2,4-dinitrotoluene generally formed in the largest proportion. 2,4-Dinitrotoluene is used as an intermediate in the manufacture of toluene diisocyanates used in polyurethane polymers, dyes, plastics, herbicides, and automobile airbags. It is also used in the manufacturing processes for explosives and propellants and as a modifier for smokeless gunpowder. DNT is commonly found at military ranges and near munitions manufacturing sites.

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Ellis HV III, Hagensen JH, Hodgson JR, Minor JL, and Hong CB. 1979. Mammalian toxicity of munitions compounds. Phase III: Effects of life-time exposure. Part I: 2,4- dinitrotoluene. Final report No.7. Fort Detrick, MD: US Army Medical Bioengineering Research and Development Laboratory. Order No. ADA077692. 281 pp. Midwest Research Institute Project No. 3900-B.

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U.S. EPA Integrated Risk Information System. 1992. EPA IRIS Chemical Assessment Summary for 2,4- Dinitrotoluene. http://www.epa.gov/iris/ (accessed 10/27/16).

U.S. EPA Integrated Risk Information System. 1990. EPA IRIS Chemical Assessment Summary for 2,4-/2,6-Dinitrotoluene mixture. http://www.epa.gov/iris/ (accessed 10/31/16).

US EPA Drinking Water Health Advisory for 2,4-Dintrotoluene and 2,6-Dinitrotoluene. 2008. Office of Water. (822-R-08-010).

U.S. EPA Provisional Peer Reviewed Toxicity Value for 2,6-Dinitrotoluene (CASRN 606-20-2). 2004. Office of Research and Development, National Center for Environmental Assessment https://hhpprtv.ornl.gov/quickview/pprtv_papers.php

U.S. EPA Provisional Peer Reviewed Toxicity Value for 2,6-Dinitrotoluene (CASRN 606-20-2). 2013. Office of Research and Development, National Center for Environmental Assessment

U.S. EPA Provisional Peer Reviewed Toxicity Value for Technical Grade Dinitrotoluene (CASRN 25321-14-6). 2013. Office of Research and Development, National Center for Environmental Assessment https://hhpprtv.ornl.gov/quickview/pprtv_papers.php

U.S. EPA Technical Fact Sheet- Dinitrotoluene (DNT). 2014. Office of Solid Waste and Emergency Response (5106P). (EPA 505-F-14-010).

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/.

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

2,4-Dinitrotoluene 121-14-2
2,6-Dinitrotoluene 606-20-2

North Carolina Groundwater (GW) Standard (2,4-dinitrotoluene) = 0.05 µg/L
North Carolina Groundwater (GW) Standard (2,6-dinitrotoluene) = 0.05 µg/L

Summary The North Carolina GW standards for 2,4-dinitrotoluene and 2,6-dinitrotoluene (2,4-DNT and 2,6-DNT) are based on a cancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below). Both isomers have been tested concurrently making it difficult to discern the isomeric contribution to reported adverse effects. Groundwater standards for each isomer are considered to be equivalent. Critical health effect: Combined incidence of mammary and liver tumors in female rats (2-year feeding study).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

	2,4-DNT	2,6-DNT	
RfD = reference dose[1]	2.0E-03	1.0E-03	mg/kg/day
WT = average adult human body weight[2]	70	70	kg
RSC= relative source contribution[3]	0.2	0.2	unitless value
WI = average daily human adult water intake[4]	2	2	L/day
1000 = conversion factor	1000	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**14**	**7**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	1.0E-06	
WT = average adult human body weight[2]	70	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	0.68	0.68	$(mg/kg\ /day)^{-1}$
WI = average daily human adult water intake[4]	2	2	L/day
1000 = conversion factor	1000	1000	µg/mg
Calculated GW Standard using cancer endpoint	**0.05**	**0.05**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**NA**	**NA**	**µg/L**
Odor Threshold[7]	**NA**	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**NA**	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[10]

10 | 10 | µg/L

References

[1] 2,4-DNT - Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 10/27/16). IRIS assessment for 2,4-dinitrotoluene last revised 6/1/92. Ellis, H.V., C.B. Hong, C.C. Lee, J.C. Dacre and J.P. Glennon. 1985. Subchronic and chronic toxicity studies of 2,4-dinitrotoluene. Part I. Beagle dogs. J. Am. College Toxicol. 4(4): 233-242. (Note that IRIS has a separate analysis for 2,4-dinitrotoluene/2,6-dinitrotoluene mixture).
2,6-DNT- Provisional Peer-Reviewed Toxicty Value (PPRTV) for 2,6-dinitrotoluene (2004). Lee, C-C., H.V. Ellis, J.J. Kowalski et al. 1976. Mammalian toxicity of munition compounds. Phase II: Effects of multiple doses. Part III: 2,6-Dinitrotoluene. Study conducted by the Midwest Research Institute for the U.S. Medical Bioengineering Research and Development Laboratory. Fort Detrick, Frederick, MD. AD A 062 015.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] Average adult water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[5] Technical grade dinitrotoluene (tg-DNT) is comprised of approximately 76% 2,4, dinitrotoluene, 20% 2,6-dinitrotoluene, and 5% other isomers. Technical grade DNT has been classifed by EPA as "likely to be carcinogenic to humans". US EPA has calculated a cancer potency factor of 0.68 $(mg/kg\text{-}day)^{-1}$ for technical grade DNT. Individual cancer potency factors for 2,4-dinitrotoluene or 2,6-dinitrotoluene are not available.

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[7] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.

[8] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 10/27/16).

[9] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.

[10] PQLs established by North Carolina Water Resources Laboratory under semi-volatiles. (https://ncdenr.s3.amazonaws.com/s3fs-public/Water%20Quality/Chemistry%20Lab/Operations/Organic%20Chemistry%20Branch/PQLsSVOA-20100212-DWQ-LAB-OPS.pdf)

NA = Not available

History

November 2010- Requested by DWM to establish NC IMAC for 2,4-dinitrotoluene.
April 1, 2011 – IMAC of 0.1 ug/L approved by DWR Director for 2,4-dinitrotoluene.

Groundwater Standard Summary Document
Division of Water Resources

1,2,4,5-TETRACHLOROBENZENE (CASRN 95-94-3)

Health Effects Summary
Human health effects associated with low, oral environmental exposures to 1,2,4,5-tetrachlorobenzene are unknown. Health effects in humans following acute exposure to 1,2,4,5-tetrachlorobenzene include skin and eye irritation from contact and nose and throat irritation from inhalation. Animals receiving oral doses of 1,2,4,5-tetrachlorobenzene experienced kidney and liver lesions, or changes to the liver and kidney.

Data used for Groundwater Standard
U.S. EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.0003 mg/kg-day for 1,2,4,5-tetrachlorobenzene based on a 90-day feeding study in rats (Chu et al., 1984). The study identified a NOAEL of 0.34 mg/kg-day based on the critical effect of increased frequency and severity of kidney lesions. An uncertainty factor of 1000 was applied (10 for variation in sensitivity among the human population, 10 for interspecies extrapolation, and 10 for extrapolation of a subchronic effect level to a chronic effect level). A systemic threshold concentration of 2 µg/L (ppb) can be calculated using the oral reference dose for 1,2,4,5-tetrachlorobenzene in accordance with 15A NCAC 02L .0202(d)(1).

At the time of the last revision of the IRIS RfD in 1987, the National Toxicology Program (NTP) was conducting toxicity studies of 1,2,4,5-tetrachlorobenzene on rats and mice. These feeding studies, published in 1991, identified a NOEL of 30 ppm (dose conversion equates to 2 mg/kg-day) for male and female rats based on histologic lesions. The rat species used in the IRIS principal study appeared to be more sensitive than the rat species used in the NTP study, and the NTP study also observed less severe endpoints. Therefore, the IRIS principal study has the most sensitive endpoint in the most sensitive species. The IRIS RfD has not been updated following the release of the NTP study results.

U.S. EPA has not classified 1,2,4,5-tetrachlorobenzene for carcinogenicity. A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

No odor threshold, taste threshold, federal maximum contaminant level or secondary drinking water standard has been established for 1,2,4,5-tetrachlorobenzene.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 2 µg/L was established under 15A NCAC 02L .0202(c) for 1,2,4,5-tetrachlorobenzene in 2010. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for 1,2,4,5-tetrachlorobenzene is 2 ug/L (ppb) based on the calculated noncancer systemic threshold.

Groundwater Standard Summary Document
Division of Water Resources

Uses:
1,2,4,5-Tetrachlorobenzene is a manmade chemical compound with a physical appearance that can range from colorless crystals to white flakes or a chunky solid. It is used to make herbicides, insecticides, and defoliants. It is also used as an intermediate to make chemicals such as 2,4,5-trichlorophenol and 2,4,5- trichlorophenoxyacetic acid.

References

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National Toxicology Program. (1991). NTP Report on the Toxicity Studies of 1,2,4,5-Tetrachlorobenzene in F344/N Rats and B6C3F1 Mice (Feed Studies). U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health. (NTP TOX 7 NIH Publication No. 91-3126)

U.S. EPA. (2018). 2018 Edition of the Drinking Water Standards and Health Advisories Tables. Office of Water (EPA 822-F-18-001) https://www.epa.gov/sites/production/files/2018-03/documents/dwtable2018.pdf

U.S. EPA. (1987). Integrated Risk Information System (IRIS) Chemical Assessment Summary for 1,2,4,5-Tetrachlorobenzene. National Center for Environmental Assessment, Office of Research and Development. https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=107 (accessed 8/06/18).

U.S. EPA. 1,2,4,5-Tetrachlorobenzene Fact Sheet (archived). https://archive.epa.gov/epawaste/hazard/wastemin/web/pdf/tetchlben.pdf

North Carolina Groundwater Standard Calculation Sheet

1,2,4,5-Tetrachlorobenzene CASRN 95-94-3

North Carolina Groundwater (GW) Standard= 2 µg/L

Summary The North Carolina GW standard for 1,2,4,5-tetrachlorobenzene is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202. Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6). Critical health effect: kidney lesions (13-week rat oral study)

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	3.00E-04	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.2	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**2**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL[9])

2 µg/L

References

[1] U.S. EPA Integrated Risk Information System (IRIS) (accessed 8/6/2018). IRIS assessment last revised 1/31/1987.
Link to document: https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0107_summary.pdf#nameddest=rfd

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] NA; 1,2,4,5-Tetrachlorobenzene has not been classified by US EPA for carcinogenicity for oral exposures. A cancer potency factor has not been established.

[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined

[7] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic

[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

[9] PQL provided for informational purposes only . PQL for 1,2,4,5-tetrachlorobenzene has not been established by the North Carolina Water Resources Laboratory. South Carolina Department of Health and Environmental Control reports a PQL of 10 µg/L for 1,2,4,5-tetrachlorobenzene, updated 8/18/2015: (https://www.scdhec.gov/sites/default/files/docs/Environment/docs/npdes_PQL.pdf).

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

August 1, 2010- IMAC of 2 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

1,1,1,2-TETRACHLOROETHANE (CASRN 630-20-6)

Health Effects Summary
Human health effects associated with low, oral environmental exposures to 1,1,1,2-tetrachlorethane are unknown. Rats and mice exhibited decreased body weight, neurotoxic effects including weakness, inactivity, and incoordination, and increased mortality following 13-week and 2-year gavage doses of 1,1,1,2-tetrachlorethane. Liver lesions were reported in a 2-year gavage study in mice.

Data used for Groundwater Standard
U.S. EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.03 mg/kg-day for 1,1,1,2-tetrachloroethane based on liver lesions in a two-year gavage study in rats (http://www.epa.gov/iris/). A systemic threshold concentration of 210 ug/L (ppb) can be calculated using the oral reference dose for 1,1,1,2-tetrachloroethane in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA classified 1,1,1,2-tetrachloroethane as a Class C Carcinogen (possible human carcinogen) based on an increased incidence of combined adenomas and carcinomas in female mice in a long term study.
U.S. EPA's Integrated Risk Information System (IRIS) established an oral cancer potency factor of 0.026 mg/kg-day for 1,1,1,2-tetrachloroethane based on liver tumors observed in long-term studies in mice (US EPA, 1996). A chronic, human drinking water exposure concentration of 1 µg/L associated with an incremental lifetime cancer risk estimate of 1×10^{-6} can be calculated using these data according to the requirements of 15A NCAC 02L .0202(d)(2).

No aqueous odor threshold, taste threshold, federal drinking water maximum contaminant level (MCL), or secondary drinking water standard has been established for 1,1,1,2-tetrachlorethane.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 1 µg/L was established under 15A NCAC 02L .0202(c) for 1,1,1,2-tetrachloroethane in 2010. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for 1,1,1,2-tetrachloroethane is 1 ug/L (ppb) based on the chronic, drinking water concentration corresponding to an incremental lifetime cancer risk of 1×10^{-6}.

Uses
1,1,1,2-tetrachlorethane is used as a solvent and in the manufacture of insecticides, bleaches, paints, woods stains, and varnishes. It is also used in the synthesis of trichloroethylene and tetrachloroethylene.

Groundwater Standard Summary Document
Division of Water Resources

References

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA Drinking Water Standards and Health Advisories. 2012. Office of Water (EPA 822-S-12-001) https://www.epa.gov/sites/production/files/2015-09/documents/dwstandards2012.pdf

U.S. EPA Integrated Risk Information System. 1996. IRIS Summary for 1,1,1,2- Tetrachloroethane. http://www.epa.gov/iris (accessed August 10, 2016)

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

1,1,1,2-Tetrachlorethane CASRN 630-20-6

North Carolina Groundwater (GW) Standard = 1 µg/L

Summary

The North Carolina GW standard for 1,1,1,2-tetrachloroethane is based on a cancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202. Groundwater standards are established as the least of the criteria in 15A NCAC 02L .0202(d)(1-6) (highlighted in yellow below).
Critical health effect: Malignant liver tumors in female mice (2-year National Toxicology Program (NTP) gavage study).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	3.00E-02	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.2	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**210**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	0.026	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**1.3**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL[9])

1 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 8/10/16). IRIS assessment last revised 12/01/1996. NTP (National Toxicology Program). 1983. Carcinogenesis studies of 1,1,1,2- tetrachloroethane (CAS No. 630-20-6) in F344/N rats and B6C3F1 mice (gavage studies). NTP-81-53; NIH Publ. No. 83-1793; NTP Technical Report Series No. 237.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 8/10/16). 1,1,1,2-tetrachloroethane has been classified by EPA as a possible human carcinogen according to the 1986 US EPA Cancer Guidelines (Category C).Carcinogenesis studies of 1,1,1,2-tetrachloroethane (CAS No. 630-20-6) in F344/N rats and B6C3F1 mice (gavage studies). NTP-81-53; NIH Publ. No. 83-1793; NTP Technical Report Series No. 237.

[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.

[7] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 7/28/16)

[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

[9] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. New Jersey reports a PQL of 1 µg for 1,1,1,2-tetrachlorethane. http://www.nj.gov/dep/wms/bears/Appendix_Table_1.htm

NA = Not available

RSC = 0.1 for nonorganics, 0.2 for organics

History

February 10, 2010 - Division of Waste Management (DWM) requested IMAC for 1,1,1,2-tetrachloroethane.
October 1, 2010 - IMAC of 1 µg/L approved by DWQ Director.

Groundwater Standard Summary Document
Division of Water Resources

1,1,2-TRICHLOROETHANE (CASRN 79-00-5)

Health Effects Summary
Human health effects associated with low, oral environmental exposures to 1,1,2-trichlorethane are unknown. Rats exposed to 1,1,2-trichlorethane in drinking water for 90-days exhibited changes in blood serum chemistry parameters indicative of adverse liver effects. Mice treated with 1,1,2-trichloroethane via gavage for 78-weeks exhibited liver and adrenal gland tumors. No treatment-related tumors were reported in rats under identical experimental conditions. Inconsistent immune responses in animal studies have been reported; their significance is unclear.

Data used for Groundwater Standard
U.S. EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.004 mg/kg-day for 1,1,2-trichloroethane based on clinical chemistry changes reported indicative of liver toxicity (http://www.epa.gov/iris). A systemic threshold concentration of 28 µg/L (ppb) can be calculated using the oral reference dose for 1,1,2-trichloroethane in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA classified 1,1,2-trichloroethane as a Class C Carcinogen (possible human carcinogen) based on an increased incidence of liver and adrenal gland tumors in mice in a long term study. U.S. EPA's Integrated Risk Information System (IRIS) established an oral cancer potency factor of 0.057 mg/kg-day for 1,1,2-trichloroethane based on these findings. A chronic, human drinking water exposure concentration of 0.6 µg/L associated with an incremental lifetime cancer risk estimate of 1×10^{-6} can be calculated using these data according to the requirements of 15A NCAC 02L .0202(d)(2).

A federal drinking water maximum contaminant level (MCL) of 5 µg/L has been established for 1,1,2- trichloroethane. No aqueous odor threshold, taste threshold, or secondary drinking water standard has been established.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 0.6 µg/L was established under 15A NCAC 02L .0202(c) for 1,1,2-trichloroethane in 2010. This value was derived using a cancer potency factor of
$0.057\ (mg/kg\text{-}day)^{-1}$ established by the EPA IRIS program. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for 1,1,2-trichloroethane is 0.6 µg/L (ppb) based on the chronic, drinking water concentration corresponding to an incremental lifetime cancer risk of 1×10^{-6}.

Uses
1,1,2-trichloroethane is used predominantly as a solvent and as a synthetic chemical intermediate in manufacture of 1,1-dichloroethane.

Groundwater Standard Summary Document
Division of Water Resources

References

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA Drinking Water Standards and Health Advisories. 2012. Office of Water (EPA 822-S-12-001) https://www.epa.gov/sites/production/files/2015-09/documents/dwstandards2012.pdf

U.S. EPA Integrated Risk Information System. 1988. IRIS Summary for 1,1,2-Trichloroethane. http://www.epa.gov/iris (accessed August 11, 2016)

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

1,1,2-Trichloroethane CASRN 79-00-5

North Carolina Groundwater (GW) Standard = 0.6 µg/L

Summary The North Carolina GW standard for 1,1,2-trichloroethane is based on a cancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202. Groundwater standards are established as the least of the criteria in 15A NCAC 02L .0202(d)(1-6) (highlighted in yellow below).
Critical health effect: Malignant liver tumors in female mice (2-year National Cancer Institute gavage study).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	4.00E-03	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.2	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**28**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	0.057	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**0.6**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**5**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL[9])

1 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 7/26/16). IRIS assessment last revised 9/30/1987. White, K.L., Jr., V.M. Sanders, D.W. Barnes, G.M. Shopp, Jr. and A.E. Munson. 1985. Toxicology of 1,1,2-trichloroethane in the mouse. Drug Chem. Toxicol. 8(5): 333-355. Sanders, V.M., K.L. White, Jr., G.M. Shopp, Jr. and A.E. Munson. 1985. Humoral and cell-mediated immune status of mice exposed to 1,1,2- trichloroethane. Drug Chem. Toxicol. 8(5): 357-372.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 7/26/16). 1,1,2-trichloroethane has been classified by EPA as a possible human carcinogen according to the 1986 US EPA Cancer Guidelines (Category C).

[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.

[7] MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 7/28/16)

[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

[9] PQL established by North Carolina Water Quality lab under volatile organics. (https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home- page/organic-chemistry-branch/methods-pqls-organics).

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

February 10, 2010 - Division of Waste Management (DWM) requested IMAC for 1,1,2-trichloroethane.
August 1, 2010 - IMAC of 0.6 µg/L approved by DWQ Directo

Groundwater Standard Summary Document
Division of Water Resources

2,4,6-TRICHLOROPHENOL (CASRN 88-06-2)

Health Effects Summary

Human health effects associated with low environmental exposures to 2,4,6-trichlorophenol are unknown. It is a solid at room temperature and causes eye, skin, and respiratory tract irritation via dermal and inhalation exposures. It is categorized as a chlorophenol and may be contaminated with trace amounts of dibenzo-p-dioxins.

Pregnant rats exposed to 2,4,6-trichlorophenol in drinking water had smaller litters compared with controls. In long-term dietary feeding studies, leukemia and lymphoma were reported in male rats while both benign and malignant tumors were reported in mice.

Data used for Groundwater Standard

U.S. EPA's Integrated Risk Information System (IRIS) has not established an oral reference dose (RfD) for 2,4,6-trichlorphenol (http://www.epa.gov/iris/).

U.S. EPA established a provisional oral reference dose (p-RfD) of 0.001 mg/kg-day for 2,4,6-trichlorophenol in 2007 (https://hhpprtv.ornl.gov/quickview/pprtv_papers.php). This value was based on decreased litter sizes reported in a reproductive study in rats. A systemic threshold concentration of 7 µg/L (ppb) can be calculated using the provisional oral reference dose for 2,4,6-trichlorophenol in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA classified 2,4,6-trichlorophenol as B2; probable human carcinogen based on an increased incidence of lymphomas and leukemias in male rats and liver tumors in male and female mice. U.S. EPA's Integrated Risk Information System (IRIS) established an oral cancer potency factor of 0.011 $(mg/kg\text{-}day)^{-1}$ for 2,4,6-trichlorophenol. A chronic, human drinking water exposure concentration of 3.18 µg/L (rounded to 3 µg/L) associated with an incremental lifetime cancer risk estimate of 1×10^{-6} can be calculated using this data according to the requirements of 15A NCAC 02L .0202(d)(2).

An aqueous taste threshold of 380 µg/L and an aqueous odor threshold of 12 µg/L has been reported for 2,4,6-trichlorophenol (Young et al., 1996). No federal drinking water maximum contaminant level (MCL) or secondary drinking water standard has been established. It is noted that an RfD of 0.0003 mg/kg-day is included in the 2012 U.S. EPA Drinking Water Standards and Health Advisories for 2,4,6-trichlorophenol. The origin of this value is unknown although a draft Health Advisory Document from 1994 is referenced.

Recommended Groundwater Standard

An interim maximum allowable concentration (IMAC) of 4 µg/L was established under 15A NCAC 02L .0202(c) for 2,4,6-trichlorophenol in 2010. Due to error in the calculation input, the value was incorrectly rounded. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for 2,4,6-trichlorophenol is 3 µg/L (ppb) based on the chronic, drinking water concentration corresponding to an incremental lifetime cancer risk of 1×10^{-6}.

Groundwater Standard Summary Document
Division of Water Resources

Uses

2,4,6-Trichlorophenol has been used as a fungicide, glue preservative, insecticide, bactericide, defoliant, herbicide, and anti-mildew agent for textiles. It has also been used as a wood preservative and as an intermediate in the manufacture of higher chlorinated phenols.

References

Agency for Toxic Substances and Disease Registry. Toxicological Profile for Chlorophenols. 1999. US Department of Health and Human Services http://www.atsdr.cdc.gov/

U.S. EPA Drinking Water Standards and Health Advisories. 2012. Office of Water (EPA 822-S-12-001) https://www.epa.gov/sites/production/files/2015-09/documents/dwstandards2012.pdf

U.S. EPA Integrated Risk Information System. 1991. IRIS Chemical Summary for 2,4,6-Trichlorophenol. http://www.epa.gov/iris (accessed December 14, 2016).

U.S. EPA Provisional Peer Reviewed Toxicity Value for 2,4,6-Trichlorophenol. 2007. Office of Research and Development, National Center for Environmental Assessment https://hhpprtv.ornl.gov/quickview/pprtv_papers.php

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

2,4,6-Trichlorophenol CASRN 88-06-2

North Carolina Groundwater (GW) Standard = 3 µg/L

Summary

The North Carolina GW standard for 2,4,6-trichlorophenol is based on a cancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202. Groundwater standards are established as the least of the criteria in 15A NCAC 02L .0202(d)(1-6) (highlighted in yellow below).
Critical health effect: Lymphomas or leukemias in male rats and liver tumors in male and female mice (2-year dietary feeding studies).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	1.0E-03	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**7**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	0.011	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**3.18**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**12**	**µg/L**
Odor Threshold[7]	**380**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[10]

10 µg/L

References

[1] EPA Provisional Peer Review Toxicity Value (PPRTV) for 2,4,6-Trichlorophenol. 2007. Exon, J.H. and L.D. Koller. 1985. Toxicity of 2-chlorophenol, 2,4-dichlorophenol, and 2,4,6-trichlorophenol. In: Water Chlorination: Chemistry, Environmental Impact and Health Effects, R.L. Jolley et al., Ed. Proceedings Fifth Conference Williamsburg, Chelsea, MI. Lewis Publishers. p. 307-330.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] Average adult water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[5] US EPA IRIS has classified 2,4,6-trichlorophenol B2 for carcinogenicity (probable human carcinogen based on sufficient evidence in animals and inadequate evidence in humans). A cancer potency factor of 0.01 (mg/kg-day)$^{-1}$ has been established. NCI (National Cancer Institute). 1979. Bioassay of 2,4,6-Trichlorophenol for Possible Carcinogenicity. U.S. DHEW Publ. No. NCI-CG-TR-155.

[6] Young WF, Horth H, Crane R, Ogden T and Arnottt M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

[7] Young WF, Horth H, Crane R, Ogden T and Arnottt M. 1996. pp. 331-340.

[8] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 12/14/16)

[9] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

[10] PQL established by North Carolina Water Resources Laboratory for 2,4,6-trichlorophenol under semivolatile organics (https://deq.nc.gov/about/divisions/water-resources/water- resources-data/water-sciences-home-page/organic-chemistry-branch/methods-pqls-organics)

NA = Not available

History

April 27, 2010 - Division of Waste Management (DWM) requested IMAC for 2,4,6-trichlorophenol. October 1, 2010 - IMAC of 4 µg/L approved by DWQ Director

Groundwater Standard Summary Document
Division of Water Resources

ACETIC ACID (64-19-7)

Health Effects Summary

Human health effects associated with oral environmental exposures to acetic acid are unknown. Chronic studies consisting of drinking water exposure in rats has been shown to decrease appetite and body weight (Solmann, 1921).

Data used for Groundwater Standard

U.S. EPA's Integrated Risk Information System (IRIS) has not established an oral reference dose (RfD) for acetic acid.

A systemic threshold concentration can be calculated for acetic acid in accordance with 15A NCAC 02L .0202(d)(1) using a no-observed-effect-level (NOAEL) of 209.8 mg/kd-day calculated from a published peer reviewed scientific paper (Solmann, 1921).

U.S. EPA has not evaluated acetic acid for carcinogenicity via oral exposures. A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1 x 10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

An odor threshold of 97,000 µg/L has been reported for acetic acid (Amoore et al.,1983).

A taste threshold of 22,000 ug/L has been reported for acetic acid (Leffingwell et al., 1991).

No federal maximum contaminant level or secondary drinking water standard has been established for acetic acid.

Recommended Groundwater Standard

A groundwater standard of 5000 µg/L is recommended under 15A NCAC 02L .0202(c) for acetic acid. This value has been rounded from the calculated value of 4900 µg/L in accordance with rounding convention. The RfD is based on a NOAEL of 0.2 cc of acid/kg body weight., or 209.8 mg/kg calculated as follows:

Density of acetic acid = 1.049 g/cc

0.2 cc/kg bodyweight X 1.049 g/cc X 1000 mg/g = 209.8 mg/kg

The 0.2 cc acid/kg body weight is identified in a 2-4 month drinking water study in rats (Solmann, 1921). An uncertainty factor of 300 (10 for intraspecies, 10 for interspecies, and 3 for extrapolation from a subchronic study to a chronic study) was used to calculate an RfD of 0.65 mg/kg-day. (209.8/300 = 0.7 mg/kg)

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

A groundwater standard of 5,000 ug/L for acetic acid is being recommended at this time.

Use

Acetic acid is used as a food additive, pickling solution, and descaling agent. Concentrated acetic acid solutions are used in industry during the production of chemicals and for the manufacture of photographic films and synthetic fibers. Acetic acid is the main component of vinegar at concentrations of about 4-8%.

References

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA Office of Pollution Prevention and Toxics. 2005.

Leffingwell JC and Leffingwell D., Leffingwell and Associates. 1991. Perfume and Flavorist- GRAS Flavor Chemicals- Detection Thresholds. Vol 16, No. 1, Jan/Feb 1991, P. 1-20.

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/.

Solmann, Torald. 1921. Studies of Chronic Intoxications on Albino Rats III. Acetic and Formic Acids. The Journal of Pharmacology and Experimental Therapeutics. Vol 16, pp. 463-474.

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Acetic Acid CASRN 64-19-7

North Carolina Ground Water (GW) Standard = 5000 µg/L

Summary The North Carolina GW standard for acetic acid is based on its noncancer threshold in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Reduced body weight in rats (2-4 month drinking water study).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	7.00E-01	(NOAEL/300)
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	unitless value
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**4900**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	NA	$(mg/kg\ /day)^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**22,000**	**µg/L**
Odor Threshold[7]	**97,000**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**µg/L**

Additional Information

European Food Safety Authority (EFSA) Scientific Opinion for Animal Species [10]	**1.E+06**	**µg/L**

Practical Quantitation Limit (PQL) [11] 1,000 µg/L

References

[1] US EPA has not established an RfD or p-RfD through its IRIS or PPRTV programs for acetic acid. The RfD is based on a NOAEL of 209.8 mg/kg calculated as follows: 0.2 cc of acid/kg body weight produced no effect on growth, appetite or consomption of fluid (Solmann, 1921,pg 474). Acetic acid density is 1.049 g/cc. 0.2 cc/kg X 1.049 g/cc X 1000 mg/g = 209.8. The extrapolated NOAEL is identified in a 2-4 month drinking water study in rats (Solmann, 1921). An uncertainty factor of 300 was used to calculate an RfD of 0.7 mg/kg-day (209.8 mg/kg/300 = 0.7 mg/kg); 10 for intraspecies, 10 for interspecies, and 3 for extrapolation from a subchronic study to a chronic study). It is noted that this study is not performed in a manner consistent with modern studies.
[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).
[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).
[4] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).
[5] Acetic acid has not been classified by EPA for carcinogenic potential. A cancer potency factor has not been established.

[6] Leffingwell JC and Leffingwell D., Leffingwell and Associates. 1991. Perfume and Flavorist- GRAS Flavor Chemicals- Detection Thresholds. Vol 16, No. 1, Jan/Feb 1991, P. 1-20.
[7] Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.
[8] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 11/1/16).
[9] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.
[10] European Food Safety Authority. 2012. Scientific Opinion on the safety and efficacy of acetic acid, sodium diacetate and calcium acetate as preservatives for feed for all animals. EFSA Journal 10(2):2571.
[11] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. PQL from NC DEQ certified commercial laboratory.

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

May 29, 2014 - Hercules Incorporated requested IMAC for acetic acid.
OSHA= 10 ppm TLV, NC AAL for acetic acid = 1.5 ppm (3.7 mg/m3) --- Also pH and presence of chlorinated acetic acids (mono, di , and triachloroacetic acids have low MCLs(60 ug/L total)

Groundwater Standard Summary Document
Division of Water Resources

ACETOCHLOR (34526-82-1)

Health Effects Summary
Human health effects associated with low environmental exposures to acetochlor are unknown. Subchronic and chronic feeding studies with acetochlor have produced treatment-related renal injury, neurologic effects in rats and dogs, nasal and thyroid tumors in rats, and lung tumors in mice. Liver and renal tumors were also observed in animal studies; however these occurred at the highest doses tested that were considered excessively toxic. Stomach tumors and benign ovarian tumors observed in mice were not considered treatment-related. No adverse developmental effects were noted in rabbit studies with acetochlor. Decreased maternal and fetal weight, decreased pup body weights during lactation, changes in organ weights (thyroid, pituitary, and ovary), decreased litter size, and maternal toxicity were reported in reproductive and developmental studies in rats.

Data used for Groundwater Standard
USEPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.02 mg/kg-day for acetochlor based on a one-year feeding study in dogs (https://www.epa.gov/iris). A systemic threshold concentration of 140 ug/L (ppb) can be calculated using the oral reference dose for acetachlor in accordance with 15A NCAC 02L .0202(d)(1).

US EPA reclassified acetochlor as having "suggestive evidence of carcinogenic potential" during its Fifth Evaluation of Carcinogenic Potential (2007). A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2). US EPA concluded in its Fifth Evaluation of Carcinogenic Potential (2007) that the chronic RfD of 0.02 mg/kg-day was protective for both non-cancer and cancer effects.

No odor threshold, taste threshold, federal maximum contaminant level or secondary drinking water standard has been established for this chemical.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 100 µg/L was established under 15A NCAC 02L .0202(c) for acetochlor in 2010. The calculated threshold concentration of 140 µg/L was rounded down to 100 µg/L in accordance with rounding conventions. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for acetochlor is 100 ug/L (ppb) based on the calculated noncancer systemic threshold.

Uses:
Acetochlor is a chloroacetanilide type herbicide with restricted usage for preemergent control of grasses and broadleaf weeds on agricultural crop land. Acetochlor degrades in water to form acetochlor ethanesulfonic acid (ESA) and acetochlor oxanilic acid (OSA).

References

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA. Acetochlor: Fifth Report of the Cancer Assessment Review Committee. January 3, 2007. TXR No. 0054494, PC Code 121601.

U.S. EPA (1993) Integrated Risk Information System. IRIS Summary for Acetochor. http://www.epa.gov/iris/ (accessed 5/17/2016).

U.S. EPA (2009). Contaminant Information Sheets for the Final CCL 3 Chemicals, Office of Water (EPA 815-R-09-012). https://www.epa.gov/ccl/contaminant-candidate-list-3-ccl-3.

U.S. EPA Report of the Food Quality Protection Act (FQPA) Tolerance Reassessment Progress and Risk Management Decision (TRED) for Acetochlor (March 2006) http://www.epa.gov/pesticides/reregistration/acetochlor/.

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/.

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Acetochlor CASRN 34256-82-1

North Carolina Ground Water (GW) Standard = 100 µg/L

Summary

The North Carolina GW standard for acetochlor is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Chronic oral exposure to acetochlor was associated with salivation, increased liver enzymes, significant increases in triglyceride and decreased blood glucose level, and histopathological changes in kidneys and testes of male dogs (1 year study).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	2.00E-02	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.2	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**140**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	$(mg/kg/day)^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[9]

4.0 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 5/17/16). IRIS assessment last revised 9/1/93. ICI, Inc. 1988a. MRID No. 41565118; HED Doc No. 008478.
[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).
[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).
[4] Acetochlor has been classified by EPA as having "suggestive evidence of carcinogenic potential". A cancer potency factor has not been established.
[5] Young WF, Horth H, Crane R, Ogden T and Arnottt M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.
[6] Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.
[7] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 5/2/2016).
[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.
[9] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. PQL from DEQ certified commercial laboratory.

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

May 18, 2010 - Request by manufacturer to establish NC IMAC for Acetochlor.=
December 1, 2010 - IMAC of 100 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

ACETOCHLOR ESA (187022-11-3)

Health Effects Summary
Human health effects associated with low environmental exposures to acetochlor ESA are unknown. However, EPA has concluded that acetochlor degradates are significantly less toxic than acetochlor and are unlikely to be carcinogenic.

Limited toxicological data exists for acetochlor ESA. Four-week and thirteen-week feeding studies in rats reported fewer toxicological effects compared with similar studies conducted with acetochlor. The critical effects were identified as reduced body weight, body weight gains, and reduced food utilization (calculated as body weight gain per 100 grams food eaten).

Data used for Groundwater Standard
US EPA has not established an RfD or carcinogenic potential classification for acetochlor ESA.

No odor threshold, taste threshold, federal maximum contaminant level or secondary drinking water standard has been established for this chemical.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 1000 µg/L was established under 15A NCAC 02L .0202(c) for acetochlor ESA in 2010. This value was based on an RfD value of 0.2 mg/kg/day reported by Gadagbui et al., 2010. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Gadagbui et al., 2010 pointed out that an argument for an RfD of 0.075 mg/kg/day could also be made based on database inadequacies for acetochlor degradates. Given the limited number of studies available for the degradates, including the lack of toxicological data from two species, use of 0.075 mg/kg/day rather than 0.2 mg/kg/day as the RfD is recommended in establishing groundwater standards.

Using an RfD of 0.075 mg/kg/day, the calculated groundwater threshold concentration for acetochlor ESA is 525 µg/L rounded down to 500 µg/L in accordance with rounding conventions.

Groundwater standards are to be the “lesser of” the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for acetochlor ESA is 500 ug/L (ppb) based on its calculated “non-cancer” systemic threshold.

Uses
Acetochlor is a chloroacetanilide type herbicide with restricted usage for preemergent control of grasses and broadleaf weeds on agricultural crop land. Acetochlor degrades in water to form acetochlor ethanesulfonic acid (ESA) and acetochlor oxanilic acid (OSA). Acetochlor ESA and Acetochlor OXA are the most commonly detected environmental degradates of acetochlor in groundwater and surface water. Their measured concentrations are generally much higher than acetochlor.

References

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

Gadagbui B, Maier A, Dourson M, Parker A, Willis A, Christopher JP, Hicks L, Ramasamy S, and Roberts SM. 2010. Derived reference doses for the environmental degradates of the herbicides alachlor and acetochlor: Results of an independent expert panel deliberation. Regulatory Toxicology and Pharmacology, 57: 220-234.

U.S. EPA (2009). Contaminant Information Sheets for the Final CCL 3 Chemicals, Office of Water (EPA 815-R-09-012). https://www.epa.gov/ccl/contaminant-candidate-list-3-ccl-3

U.S. EPA Report of the Food Quality Protection Act (FQPA) Tolerance Reassessment Progress and Risk Management Decision (TRED) for Acetochlor (March 2006) http://www.epa.gov/pesticides/reregistration/acetochlor/.

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Acetochlor ESA CASRN 187022-11-3

North Carolina Groundwater (GW) Standard = 500 µg/L

Summary The North Carolina GW Standard for acetochlor ESA, a degradate of the herbicide, acetochlor, is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health endpoint: Reduced body weight, body weight gains, and food utilization in rats following subchronic oral exposures (90-day study).

GW Standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	7.50E-02	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.2	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**525**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	$(mg/kg\ /day)^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[9]

0.4 µg/L

References

[1] Gadagbui B, Maier A, Dourson M, Parker A, Willis A, Christopher JP, Hicks L, Ramasamy S, and Roberts SM. 2010. Derived reference doses for the environmental degradates of the herbicides alachlor and acetochlor: Results of an independent expert panel deliberation. *Regulatory Toxicology and Pharmacology*, 57: 220-234. Uncertainty factor of 3000 rather than 1000 used to derive RfD based on database insufficiency (Publication Footnote 2).
[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).
[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).
[4] NA; Acetochlor ESA has not been classified for carcinogenicity by US EPA or IARC due to a lack of experimental data. A cancer potency factor is not available.
[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.
[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.
[7] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 5/2/2016).
[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.
[9] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. EPA method 535 (Table 5) cites a Lowest Concentration Minimum Reporting Level (LCMRL) for a triple quadrapole analysis of acetochlor ESA (https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=103915&simpleSearch=1&searchAll=535).

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

May 18, 2010 - Request by manufacturer to establish NC IMAC for Acetochlor ESA
December 1, 2010 - IMAC of 1000 µg/L approved by DWR Director. Recommended IMAC rounded down from 1400 µg/L.

Groundwater Standard Summary Document
Division of Water Resources

ACETOCHLOR OXA (184992-44-4)

Health Effects Summary
Human health effects associated with low environmental exposures to acetochlor OXA are unknown. However, EPA has concluded that acetochlor degradates are significantly less toxic than acetochlor and are unlikely to be carcinogenic.

Limited toxicological data exists for acetochlor OXA. Four-week and thirteen-week feeding studies in rats reported fewer toxicological effects compared with similar studies conducted with acetochlor. The critical effects were identified as reduced body weight, body weight gains, and reduced food utilization (calculated as body weight gain per 100 grams food eaten).

No treatment-related developmental effects were noted in a two-week rat developmental toxicity study conducted with acetochlor OXA although maternal toxicity was reported. The NOAEL for developmental effects was the highest dose tested (1000 mg/kg/day).

Data used for Groundwater Standard
US EPA has not established an RfD or carcinogenic potential classification for acetochlor OXA.

No odor threshold, taste threshold, federal maximum contaminant level or secondary drinking water standard has been established for this chemical.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 1000 µg/L was established under 15A NCAC 02L .0202(c) for acetochlor OXA in 2010. This value was based on an RfD value of 0.2 mg/kg/day reported by Gadagbui et al., 2010. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Gadagbui et al., 2010 pointed out that an argument for an RfD of 0.075 mg/kg/day could also be made based on database inadequacies for acetochlor degradates. Given the limited number of studies available for the degradates, including the lack of toxicological data from two species, use of 0.075 mg/kg/day rather than 0.2 mg/kg/day as the RfD is recommended in establishing groundwater standards.

Using an RfD of 0.075 mg/kg/day, the calculated groundwater threshold concentration for acetochlor OXA is 525 µg/L rounded down to 500 µg/L in accordance with rounding conventions.

Groundwater standards are to be the “lesser of” the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for acetochlor OXA is 500 ug/L (ppb) based on its calculated noncancer systemic threshold.

Uses
Acetochlor is a chloroacetanilide type herbicide with restricted usage for preemergent control of grasses and broadleaf weeds on agricultural crop land. Acetochlor degrades in water to form acetochlor ethanesulfonic acid (ESA) and acetochlor oxanilic acid (OSA). Acetochlor ESA and Acetochlor OXA are the most commonly detected environmental degradates of acetochlor in groundwater and surface water. Their measured concentrations are generally much higher than acetochlor.

References

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

Gadagbui B, Maier A, Dourson M, Parker A, Willis A, Christopher JP, Hicks L, Ramasamy S, and Roberts SM. 2010. Derived reference doses for the environmental degradates of the herbicides alachlor and acetochlor: Results of an independent expert panel deliberation. Regulatory Toxicology and Pharmacology, 57: 220-234.

U.S. EPA (2009). Contaminant Information Sheets for the Final CCL 3 Chemicals, Office of Water (EPA 815-R-09-012). https://www.epa.gov/ccl/contaminant-candidate-list-3-ccl-3

U.S. EPA Report of the Food Quality Protection Act (FQPA) Tolerance Reassessment Progress and Risk Management Decision (TRED) for Acetochlor (March 2006) http://www.epa.gov/pesticides/reregistration/acetochlor/.

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Acetochlor OXA CASRN 184992-44-4

North Carolina Groundwater Standard = 500 µg/L

Summary

The North Carolina GW Standard for acetochlor OXA, a degradate of the herbicide, acetochlor, is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health endpoint: Reduced body weight, body weight gains, and food utilization in rats following subchronic oral exposures (90-day study).

GW Standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	7.50E-02	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.2	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**525**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	$(mg/kg\ /day)^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[9]

0.5 µg/L

References

[1] Gadagbui B, Maier A, Dourson M, Parker A, Willis A, Christopher JP, Hicks L, Ramasamy S, and Roberts SM. 2010. Derived reference doses for the environmental degradates of the herbicides alachlor and acetochlor: Results of an independent expert panel deliberation. *Regulatory Toxicology and Pharmacology* , 57: 220-234. Uncertainty factor of 3000 rather than 1000 used to derive RfD based on database insufficiency (Publication Footnote 2).

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] Acetochlor OXA has not been classified for carcinogenicity by US EPA or IARC due to a lack of experimental data. A cancer potency factor is not available.

[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.

[7] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 5/2/2016).

[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.

[9] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. EPA method 535 (Table 5) cites a Lowest Concentration Minimum Reporting Level (LCMRL) for a triple quadrapole analysis of acetochlor OXA (https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=103915&simpleSearch=1&searchAll=535).

NA = Not available

RSC = 0.1 for nonorganics, 0.2 for organics

History

May 18, 2010 - Request by manufacturer to establish NC IMAC for Acetochlor OXA.

December 1, 2010 - IMAC of 1000 µg/L approved by DWR Director. Recommended IMAC rounded down from 1400 µg/L.

Groundwater Standard Summary Document
Division of Water Resources

ACETOPHENONE (98-86-2)

Health Effects Summary
Human health effects associated with low environmental exposures to acetophenone are unknown. Limited toxicological data exist for acetophenone. No effects were reported in a 17-week feeding study in rats for three parameters assessed (growth, hematological, and macroscopic tissue changes). Non-published and non-peer-reviewed rat feeding studies reported increased liver and kidney weights, decreased grip strength and motor activity, decreased pup survival, decreased pup body weight during lactation, and decreased live birth index. The relevance of these data to human exposures are unknown.

Data used for Groundwater Standard
US EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.1 mg/kg-day for acetophenone based on a 17-week feeding study in rats. A systemic threshold concentration of 700 ug/L (ppb) can be calculated using the oral reference dose for acetophenone in accordance with 15A NCAC 02L .0202(d)(1).

US EPA classified acetophenone as Class D, not classifiable as to human carcinogenicity due to a lack of data. A cancer potency factor is not available and a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

An odor threshold of 68,000 µg/L has been reported for acetophenone in water (Verschueren, 1996). No taste threshold, federal maximum contaminant level or secondary drinking water standard has been established for acetophenone.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 700 µg/L was established under 15A NCAC 02L .0202(c) for acetophenone in 2010. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for acetophenone is 700 ug/L (ppb) based on the calculated noncancer systemic threshold.

Uses
Acetophenone is used as a fragrance ingredient in soaps, detergents, creams, lotions, and perfumes. It is also used as a flavoring agent in food products, nonalcoholic beverages and tobacco. Industrially, acetophenone is used as a solvent for synthetic syntheses and as a catalyst for olefin polymerization.

References
Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA. Provisional Peer Reviewed Toxicity Values for Acetophenone. 2011. Office of Research and Development, National Center for Environmental Assessment https://hhpprtv.ornl.gov/quickview/pprtv_papers.php

U.S. EPA. 1998. Integrated Risk Information System. Acetophenone. http://www.epa.gov/iris (accessed May 25, 2016).

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Verschueren, Karel. 1996. Handbook of Environmental Data on Organic Chemicals. 3rd edition. International Thomson Publishing company (ITP), New York, New York.

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Acetophenone CASRN 98-86-2

North Carolina Groundwater (GW) Standard = 700 µg/L

Summary

The North Carolina GW standard for acetophenone is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: No effects were reported in a 17-week feeding study in rats for three parameters assessed (growth, hematological, and macroscopic tissue changes).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	1.00E-01	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.2	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**700**	**µg/L**

GW standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	$(mg/kg/day)^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	NA	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**68,000**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[9] 2 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed May 25, 2016). IRIS assessment revised 8/22/1998 for oral RfD and 2/1/1999 for carcinogenicity. Hagan EC, Hansen WH, Fitzhugh OG et al., 1967. Food flavorings and compounds of related structure. II. Subacute and chronic toxicity. Food Cosmet. Toxicol. 5:141-157.
[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).
[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).
[4] NA; Acetophenone has been classified by EPA as Category D: not classifiable as to human carcinogenicity. A cancer potency factor has not been established.
[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.
[6] Verschueren, Karel. 1996. Handbook of Environmental Data on Organic Chemicals. 3rd edition. International Thomson Publishing company (ITP), New York, New York.
[7] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 5/25/2016).
[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.
[9] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. PQL from DEQ certified commercial laboratory.

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

May 18, 2010 - NC Division of Waste Management requested IMAC for acetophenone.
April 1, 2011 - IMAC of 700 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

BENZYL ALCOHOL (100-51-6)

Health Effects Summary
Human health effects associated with low environmental exposures to benzyl alcohol are unknown. Benzyl alcohol is an eye irritant and has demonstrated sensitization properties in animals. Following ingestion, benzyl alcohol is metabolized to benzoic acid. Benzyl alcohol administered intravenously to newborns as a vaccine constituent may cause severe toxicity, including death. The toxicity is due to the neonate's inability to metabolize benzyl alcohol and its subsequent accumulation has been linked with "gasping syndrome".

Data used for Groundwater Standard
U.S. EPA's Integrated Risk Information System (IRIS) has not established an oral reference dose (RfD) for benzyl alcohol.

U.S. EPA has derived a Provisional Peer-Reviewed Toxicity Value (PPRTV) for benzyl alcohol. PPRTVs are developed using similar methods, data sources, and Agency guidance that are used by the IRIS program in order to derive toxicity values from relevant scientific literature. A provisional oral reference dose (p-RfD) of 0.1 mg/kg-day for benzyl alcohol was derived. No adverse effects were identified in a 2-year National Toxicology Program (NTP) study in mice; therefore, the highest dose tested was used as the point of departure (POD) for deriving the p-RfD. A systemic threshold concentration of 700 ug/L (ppb) can be calculated using the oral reference dose for benzyl alcohol in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA has classified benzyl alcohol as a Class D carcinogen (unclassifiable as to human carcinogenicity). A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

No odor threshold, taste threshold, federal maximum contaminant level (MCL) or secondary drinking water standard has been established for benzyl alcohol.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 700 µg/L was established under 15A NCAC 02L .0202(c) for benzyl alcohol in 2010. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for benzyl alcohol is 700 ug/L (ppb) based on the calculated noncancer systemic threshold.

Uses
Benzyl alcohol is used as a flavoring additive for foods; it is also found in natural food products such as fruit and green and black tea. Benzyl alcohol is used as a constituent of intramuscularly administered local anaesthetics due to is ability to reduce pain at the injection site. It is used in perfumes, cosmetics and as a solvent and viscosity–decreasing agent.

References

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA. Provisional Peer Reviewed Toxicity Values for Benzyl Alcohol. 2009. Office of Research and Development, National Center for Environmental Assessment. https://hhpprtv.ornl.gov/quickview/pprtv_papers.php

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/.

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

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North Carolina Groundwater Standard Calculation Sheet

Benzyl Alcohol CASRN 100-51-6

North Carolina Groundwater (GW) Standard = 700 µg/L

Summary

The North Carolina GW standard for benzyl alcohol is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: None identified in 2-year NTP study. Reference dose (RfD) based on highest dose tested in mice.

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	1.0E-01	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	unitless value
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**700**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	NA	$(mg/kg\ /day)^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**NA**	**µg/L**
Odor Threshold[7]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[10]

30 µg/L

References

[1] EPA Provisional Peer Review Toxicity Value for Benzyl Alcohol. 2009. National Toxicology Program (NTP) Technical Reports on Toxicology and Carcinogenesis Studies of Benzyl Alcohol (CAS No. 100-51-6) in F344/N Rats and B6C3F1 Mice (Gavage Studies). 1989. NTP 343. NIH Publication No. 89-2599.
[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).
[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).
[4] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).
[5] NA; Benzyl alcohol has not been classified by EPA for carcinogenic potential. A cancer potency factor has not been established.
[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.
[7] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.
[8] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 9/1/16).
[9] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.
[10] PQL provided for informational purposes only. PQL established by North Carolina Water Resources Laboratory for benzyl alcohol. (https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/organic-chemistry-branch/methods-pqls-organics).

NA = Not available

History

April 27, 2010 - Request by DWM to establish IMAC for benzyl alcohol.=
October 1, 2010 - IMAC of 700 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

BROMOMETHANE (METHYL BROMIDE) (74-83-9)

Health Effects Summary
Human health effects associated with low, oral environmental exposures to bromomethane are unknown. Bromomethane is an odorless and colorless gas that may cause neurotoxic effects including headache, nausea, vomiting, incoordination, skin, eye, and respiratory irritation following inhalation. Paralysis, convulsions, coma and death may also occur following acute inhalation exposures to high concentrations of bromomethane. However, similar effects have not been reported in animals exposed via ingestion of bromomethane dissolved in oil or bromomethane fumigated foods. Rats gavaged with bromomethane dissolved in oil during a three-month study exhibited irritation and hyperplasia of the lining of the forestomach.

Data used for Groundwater Standard
U.S. EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.0014 mg/kg-day for bromomethane based on diffuse hyperplasia observed in the forestomach of rats during a 13-week gavage study. A systemic threshold concentration of 10 ug/L (ppb) can be calculated using the oral reference dose for bromomethane in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA has classified bromomethane as a Class D carcinogen (unclassifiable as to human carcinogenicity). A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

No odor threshold, taste threshold, federal maximum contaminant level (MCL) or secondary drinking water standard has been established for bromomethane.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 10 µg/L was established under 15A NCAC 02L .0202(c) for bromomethane in 2010. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for bromomethane is 10 ug/L (ppb) based on the calculated noncancer systemic threshold.

Uses
Bromomethane is an odorless, colorless gas used as a fumigant to control spiders, mites, rodents, fungi, plants, insects and nemotides. It has been used to fumigate agricultural settings, grain elevators, mills, ships, clothes, furniture, and greenhouses. It is classified as a 'Restricted Use Pesticide" by US EPA which limits its purchase and use to certified applicators or persons under their direct supervision. Bromomethane is also used to degrease wool, extract oils from nuts and seeds and as a synthetic methylating agent.

Bromomethane is classified as a Class I ozone-depleting substance. Under the Montreal Protocol, methyl bromide produced and imported in the U.S. was scheduled to be phased out in 2000. However, bromomethane was granted a critical use exemption until 2017.

References

Agency for Toxic Substances and Disease Registry. Toxicological Profile for Bromomethane. 1992. http://www.atsdr.cdc.gov/

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA Integrated Risk Information System. 1998. IRIS Summary for Bromomethane. http://www.epa.gov/iris/ (accessed 9/1/2016).

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/.

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Bromomethane CASRN 74-83-9

North Carolina Groundwater (GW) Standard = 10 µg/L

Summary The North Carolina GW standard for bromomethane is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Diffuse hyperplasia of the forestomach (13-week rat gavage study using bromomethane in arachis oil).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	1.4E-03	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	unitless value
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**10**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	NA	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**NA**	**µg/L**
Odor Threshold[7]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[10] 2 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 9/1/16). IRIS assessment last revised 9/26/88. Danse, L.H.J.C., F.L. van Velsen and C.A. van der Heijden. 1984. Methylbromide: Carcinogenic effects in the rat forestomach. Toxicol. Appl. Pharmacol. 72: 262-271.
[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).
[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).
[4] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).
[5] Bromomethane has been classified by US EPA as Group D for carcinogenicity (not classifiable as to human carcinogenicity). A cancer potency factor has not been
[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.
[7] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.
[8] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 9/1/2016).
[9] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.
[10] PQL provided for informational purposes only. PQL established by North Carolina Water Resources Laboratory for bromomethane (https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-scienceshome-page/organic-chemistry-branch/methods-pqls-organics).

NA = Not available

History

February 10, 2010 - Request by DWM to establish NC IMAC for bromomethane.=
August 1, 2010 - IMAC of 100 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

N-BUTANOL (71-36-3)

Health Effects Summary
Human health effects associated with low environmental exposures to n-butanol are unknown. There are limited toxicological data available for oral exposures to n-butanol. Rats exposed to n-butanol via gavage for 13 weeks exhibited central nervous system effects including hypoactivity and ataxia (lack of muscle coordination).

Data used for Groundwater Standard
US EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.1 mg/kg-day for n-butanol (http://www.epa.gov/iris/). A systemic threshold concentration of 700 µg/L (ppb) can be calculated using the RfD for n-butanol in accordance with 15A NCAC 02L .0202(d)(1).

US EPA has not evaluated n-butanol for carcinogenicity via oral exposures. A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1 x 10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

An odor threshold in aqueous solutions of 590 µg/L has been reported for n-butanol (Czerny et al., 2008). No taste threshold, federal maximum contaminant level or secondary drinking water standard has been established.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 700 µg/L was established under 15A NCAC 02L .0202(c) for n-butanol in 2010. A more recent publication reporting a lower aqueous odor threshold for n-butanol than previously reported was located. Czerny et al., 2008 reported an aqueous threshold of 590 µg/L for n-butanol compared with 7,100 µg/L reported by Amoore et al., 1983.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for n-butanol is 590 µg/L (ppb) based on its aqueous odor threshold.

Uses
N-butanol is used as a solvent for dyes, as an additive for polishers, cleaners, de-icing fluids, and gasoline. It is used in the pharmaceutical industry as an extractant for naturally occurring antibiotics, hormones, vitamins, alkaloids, and camphor. It is also used as a feedstock in the industrial synthesis of glycol ethers, butyl monocarboxylates, and butyl xanthate.

References
Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

Czerny M, Christlbauer M, Christlbauer M, Fisher A, Granvogl M, Hammer M, Hartl C, Noelia MH, and Schieberle. 2008. Re-investigation on odour thresholds of key food aroma compounds and development of an aroma language based on odour qualities of defined aqueous odorant solutions. European Food Research and Technology. 228:265-273.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA Integrated Risk Information System. 1987. IRIS Summary for n-Butanol. http://www.epa.gov/iris/subst/0129.htm (accessed 7/29/2016).

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

n-Butanol CASRN 71-36-3

North Carolina Groundwater (GW) Standard = 590 µg/L

Summary The North Carolina GW standard for n-butanol is based on its odor threshold in water in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Odor in aqueous solutions (not health-based).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	1.0E-01	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.2	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**700**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	$(mg/kg/day)^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**590**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[9]

50 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 7/26/16). IRIS assessment last revised 3/31/87. U.S. EPA. 1986. Butanol: Rat oral subchronic toxicity study. Office of Solid Waste, Washington, DC.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] NA; n-Butanol is classified as Group Category D (not classifiable to human carcinogenicity). A cancer potency factor is not available.

[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[6] Czerny M, Christlbauer M, Christlbauer M, Fisher A, Granvogl M, Hammer M, Hartl C, Noelia MH, and Schieberle. 2008. Re-investigation on odour thresholds of key food aroma compounds and development of an aroma language based on odour qualities of defined aqueous odorant solutions. Eur Food Res Technol. 228:265-273.

[7] MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 7/26/2016)

[8] SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

[9] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. PQL from DEQ certified commercial laboratory.

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

February 2010 - Request by DWM to establish NC IMAC for n-butanol.=
August 1, 2010 - IMAC of 700 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

Sec-BUTANOL (78-92-2)

Health Effects Summary
Human health effects associated with low environmental exposures to sec-butanol are unknown. There are limited toxicological data available for oral exposures to sec-butanol with only a single animal study located. Rats exposed to sec-butanol in drinking water in a multigenerational reproductive and developmental study had reduced body weights and their offspring had reduced weight and survival.

Data used for Groundwater Standard
U.S. EPA's Integrated Risk Information System (IRIS) has not established an oral reference dose (RfD) for sec-butanol. A provisional oral reference dose (p-RfD) of 2.0 mg/kg-day based on decreased weight in offspring is available for sec-butanol (https://hhpprtv.ornl.gov/quickview/pprtv_papers.php). A systemic threshold concentration of 14,000 µg/L (ppb) can be calculated using the provisional oral reference dose for sec-butanol in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA has not evaluated sec-butanol for carcinogenicity. A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1 x 10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

An odor threshold in aqueous solutions of 19,000 µg/L has been reported for sec-butanol (Amore and Hautala, 1983). No taste threshold, federal maximum contaminant level or secondary drinking water standard has been established.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 10,000 µg/L was established under 15A NCAC 02L .0202(c) for sec-butanol in 2010. The calculated threshold concentration of 14,000 µg/L was rounded down to 10,000 µg/L in accordance with rounding conventions. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for sec-butanol is 10,000 µg/L (ppb) based on the calculated noncancer systemic threshold.

Uses
The majority of sec-butanol is used in the industrial manufacture of methyl ethyl ketone (MEK). It is also used as a solvent for lacquers, paint removers, adhesives, surfactants, perfumes, and hydraulic brake fluids.

References
Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA. Provisional Peer Reviewed Toxicity Values for sec-Butanol. 2009. Office of Research and Development, National Center for Environmental Assessment. https://hhpprtv.ornl.gov/quickview/pprtv_papers.php

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

sec-Butanol CASRN 78-92-2

North Carolina Groundwater (GW) Standard = 10,000 µg/L

Summary

The North Carolina GW standard for sec-butanol is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Developmental toxicity (decreased pup weight) in 2-generation reproductive/developmental drinking water studies in rats.

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	2.00E+00	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.2	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**14000**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**19,000**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[9]

250 µg/L

References

[1] EPA Provisional Peer Reviewed Toxicity Values for sec-Butyl alcohol. 2009. Cox, G.E., D.E. Bailey and K. Morgareidge. 1975. Toxicity studies in rats with sec-butyl alcohol including growth, reproduction and teratologic observations. Food and Drug Research Laboratories, Inc., Waverly, NY. Report No. 91MR R 1673 (https://hhpprtv.ornl.gov/issue_papers/Butylalcoholsec.pdf).

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] NA; EPA has not evaluated sec-butanol for carcinogenicity. A cancer potency factor is not available.

[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[6] Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

[7] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 7/21/2016)

[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

[9] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. PQL from DEQ certified commercial laboratory.

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

April/June 2010 - Request by DWM to establish NC IMAC for sec-butanol.=
October 1, 2010 - IMAC of 10,000 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

4-CHLOROTOLUENE (CASRN 106-43-4)

Health Effects Summary

Human health effects associated with low environmental exposures to 4-chlorotoluene are unknown. There are no chronic animal or human toxicological studies available for 4-chlorotoluene. Short-term, 14-day and 90-day gavage studies in rats reported mortality at the highest does tested (Terrill, 1990). Decreased body weights and body weight gains, decreased organ weights, kidney-related clinical chemistry changes and histopathological changes in the liver, kidney, and adrenal glands were also reported.

Data used for Groundwater Standard

U.S. EPA's Integrated Risk Information System (IRIS) has not established an oral reference dose (RfD) for 4-chlorotoluene.

U.S. EPA established a provisional chronic oral RfD for 4-chlorotoluene of 0.02 mg/kg-day in 2004. This value was withdrawn as an RfD and replaced with a screening level in 2009. A systemic threshold concentration cannot be calculated for 4-chlorotoluene in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA has established a screening chronic oral provisional RfD of 0.02 mg/kg-day for 4-chlorotoluene effective 2009. There is large uncertainty associated with this value and EPA cautions that screening values "are not defensible as the primary driver in making cleanup decisions because they are based on limited information." As a general rule, screening levels are not used to establish groundwater standards. (https://hhpprtv.ornl.gov/quickview/pprtv_papers.php).

U.S. EPA has classified 4-chlorotoluene as a Class D carcinogen (unclassifiable as to human carcinogenicity). A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

An aqueous odor threshold of 60 µg/L and a taste threshold in water of 24 µg/L has been reported for 4-chlorotoluene (Young et al., 1996). No federal maximum contaminant level (MCL) or secondary drinking water standard has been established. The U.S. EPA has established a Drinking Water Health Advisory of 100 µg/L for 4-chlorotoluene using an RfD value of 0.02 mg/kg-day. The California Water Board has established a Notification Level of 140 µg/L using the same value.

Recommended Groundwater Standard

An interim maximum allowable concentration (IMAC) of 24 µg/L was established under 15A NCAC 02L .0202(c) for 4-chlorotoluene in 2010. The withdrawal of the p-RfD for p-chlorotoluene and its reclassification as a screening level does not influence the groundwater standard recommendation.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for 4-chlorotoluene is 24 ug/L (ppb) based on its aqueous taste threshold.

Groundwater Standard Summary Document
Division of Water Resources

Uses

4-Chlorotoluene is used in agrochemicals, plasticizers, flame retardants for plastics, material preservatives, pigments and optical brighteners, antiaging agents, pharmaceuticals, capacitor oils, thermal oils, perfumes, and flavorings (BUA, 1989).

References

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

BUA (Beratergremium für Umweltrelevante Altstoffe). (1989) Chlorotoluenes (Methylchlorobenzenes). GDCh-Advisory Committee on Existing Chemicals of Environmental Relevance. Weinheim. 38.

California Water Resources Control Board, Drinking Water Notification Levels (accessed September 19, 2016) http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/notificationlevels/notificationlevels.pdf

Terrill, JB., Robinson, M., Wolfe, GW., and Billups, LH. 1990. Subacute and subchronic oral toxicity of p-chlorotoluene in the rat. Int. J Toxicol 9: 487-495.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA. Provisional Peer Reviewed Toxicity Values for p-Chlorotoluene. 2009. Office of Research and Development, National Center for Environmental Assessment. https://hhpprtv.ornl.gov/quickview/pprtv_papers.php

U.S. EPA. Provisional Peer Reviewed Toxicity Values for p-Chlorotoluene. 2004. Office of Research and Development, National Center for Environmental Assessment.

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/.

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

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North Carolina Groundwater Standard Calculation Sheet

4-Chlorotoluene CASRN 106-43-4

North Carolina Groundwater (GW) Standard = 24 µg/L

Summary The North Carolina GW standard for 4-chlorotoluene is based on its aqueous taste threshold in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Aqueous taste threshold (not health-based).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	2.0E-02	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	unitless value
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**140**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	NA	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**24**	**µg/L**
Odor Threshold[7]	**60**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**µg/L**

Additional Information

U.S. EPA Drinking Water Health Advisory [10]	**100**	**µg/L**
California Water Board Notification Level [11]	**140**	**µg/L**

Practical Quantitation Limit (PQL) [12]

1 µg/L

References

[1] US EPA has not established an RfD or p-RfD through its IRIS or PPRTV programs for 4-chlorotoluene due a lack of chronic toxicological studies. The value cited here is a SCREENING VALUE derived by the PPRTV program. The SCREENING VALUE is based on a NOAEL of 200 mg/kg identified in a 90-day gavage rat study (1990). US EPA states that "Screening values are not defensible as the primary drivers in making cleanup decisions because they are based on limited information.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] Average adult water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[5] NA; 4-Chlorotoluene has not been classified by EPA for carcinogenic potential. A cancer potency factor has not been established.

[6] Young WF, Horth H, Crane R, Ogden T and Arnottt M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

[7] Young WF, Horth H, Crane R, Ogden T and Arnottt M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

[8] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 9/19/16).

[9] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.

[10] U.S. EPA Drinking Water Standards and Health Advisories (2012).https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic

[11] http://www.swrcb.ca.gov/drinking_water/certlic/drinkingwater/NotificationLevels.shtml

[12] PQL provided for informational purposes only. PQL established by North Carolina Water Resources Laboratory for 4-chlorotoluene. (https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/microbiology-inorganics-branch/methods-pqls-qa).

NA = Not available

History

April 27, 2010 - Request by DWM to establish IMAC for 4-chlorotoluene.
October 1, 2010 - IMAC of 24 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

DALAPON (CASRN 75-99-0)

Health Effects Summary
Human health effects associated with low, oral environmental exposures to dalapon are unknown. Dalapon is a severe eye and skin irritant and may cause slowed heartbeat, vomiting, diarrhea, fatigue, pain, and irritation of the respiratory tract following inhalation. In a 2-year feeding study in rats, increased kidney weights was reported. In reproductive studies, reduced pup weight and decreased weight gain were reported at the highest dalapon doses tested but not at the lower doses.

Data used for Groundwater Standard
U.S. EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.03 mg/kg-day for dalapon based on reduced kidney to body weight ratios reported in a two-year feeding study in rats (https://www.epa.gov/iris). A systemic threshold concentration of 210 ug/L (ppb) can be calculated using the oral reference dose for dalapon in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA has not classified dalapon for carcinogenic potential. A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

An aqueous odor threshold of >11, 000 µg/L has been reported for dalapon (Young et al., 1986). A federal maximum contaminant level (MCL) of 200 µg/L has been established for dalapon. No taste threshold or secondary drinking water standard has been established for this chemical.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 200 µg/L was established under 15A NCAC 02L .0202(c) for dalapon in 2010. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for dalapon is 200 ug/L (ppb) based on its Federal Maximum Contaminant Level (MCL) and calculated noncancer systemic threshold.

Uses:
Dalapon, in its water-soluble sodium or magnesium salt forms, is a pre-emergent and post-emergent herbicide used to control Bermuda grass, Johnson grass, cattails and rushes in food crops. It is used primarily on sugarcane and sugar beets but also on potatoes, carrots, asparagus, alfalfa, and flax. It has also been used for non-crop applications such as lawns, drainage ditches, along railroad tracks and industrial areas. It is generally applied as a foliar spray.

References

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA Integrated Risk Information System. 1988. IRIS Summary for Dalapon, sodium salt. http://www.epa.gov/iris/ (accessed 9/20/2016).

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/.

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Dalapon CASRN 75-99-0

North Carolina Groundwater (GW) Standard = 200 µg/L

Summary The North Carolina GW standard for dalapon (2,2-dichloropropionic acid) is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Increased kidney:body weight ratios in male rats (2-year feeding study).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	3.0E-02	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	unitless value
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**210**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	NA	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**NA**	**µg/L**
Odor Threshold[7]	**> 11,000**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**200**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[10] 4 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 9/20/16). IRIS assessment last revised 8/22/1988. Paynter, O.E., Tusing D.D., McCollister D.D., and Rowe, V.K. 1960. Toxicology of Dalapon Sodium (2,2-dichloropropionic acid, sodium salt). J. Agriculture Food Chemicals. 8: 47-51.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] Average adult water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[5] NA; Dalapon has not been classified by EPA for carcinogenic potential. A cancer potency factor has not been established.

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[7] Young WF, Horth H, Crane R, Ogden T and Arnottt M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

[8] MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 9/20/2016).

[9] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.

[10] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. PQL from DEQ certified commercial laboratory.

NA = Not available

History

February 10, 2010 - Request by DWM to establish NC IMAC for dalapon.=
August 1, 2010 - IMAC of 200 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

1,4-DIBROMOBENZENE (CASRN 106-37-6)

Health Effects Summary
Human health effects associated with low environmental exposures to 1,4,-dibromobenzene are unknown. There are limited toxicological data available for 1,4-dibromobenzene. Liver to body-weight ratio and liver enzyme activity were increased in rats administered 1,4-dibromobenzene dissolved in corn oil for 45 and 90 days via gavage. However, these effects were reported to be reversible within 30-days post-exposure.

Data used for Groundwater Standards
U.S. EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.01 mg/kg-day for 1,4-dibromobenzene based on reversible liver effects. A systemic threshold concentration of 70 µg/L can be calculated using the oral reference dose for 1,4-dibromobenzene in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA has not evaluated 1,4-dibromobenzene for carcinogenicity. A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1 x 10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

No taste threshold, federal maximum contaminant level (MCL) or secondary drinking water standard has been established for 1,4-bromobenzene.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 70 µg/L was established under 15A NCAC 02L .0202(c) for 1,4-dibromobenzene in 2010. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for 1,4-dibromobenzene is 70 ug/L (ppb) based on the calculated noncancer systemic threshold.

Uses
1,4-dibromobenzene is a white to grayish crystalline powder with a xylene-like odor. It is used in the manufacture of pharmaceuticals, pesticides, and flame retardants.

References
Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

Carlson, G.P. and Tardiff, R.G. Effect of 1.4-dibromobenzene and 1,2,4-tribromobenzene on xeniobiotic metabolism. Toxicol. Appl. Pharmacol. 42:189-196.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA Integrated Risk Information System. 2003. Chemical Assessment Summary of 1,4-Dibromobenzene. http://www.epa.gov/iris (accessed October 3, 2016).

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

1,4-Dibromobenzene CASRN 106-37-6

North Carolina Groundwater (GW) Standard = 70 µg/L

Summary

The North Carolina GW standard for 1,4-dibromobenzene is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Increased liver to body weight ratio and liver enzyme activity in 90-day rat gavage study.

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	1.0E-02	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	unitless value
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpo	**70**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	NA	$(mg/kg\ /day)^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**NA**	**µg/L**
Odor Threshold[7]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[10]

1 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 9/30/16). IRIS assessment last revised 3/31/87. Carlson, G.P. and Tardiff, R.G. Effect of 1.4-dibromobenzene and 1,2,4-tribromobenzene on xeniobiotic metabolism. Toxicol. Appl. Pharmacol. 42:189-196.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[5] NA; US EPA determined there was inadequate information to assess the carcinogenic potential of 1,4-dibromobenzene. A cancer potency factor is not available.

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[7] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.

[8] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 9/20/16)

[9] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

[10] PQL provided for informational purposes only. PQL established by North Carolina Water Resources Laboratory for chemically similar compound, bromobenzene. (https://deq.nc.gov/about/divisions/waterresources/ water-resources-data/water-sciences-home-page/microbiology-inorganics-branch/methods-pqls-qa).

NA = Not available

History

February 10, 2010 - Division of Waste Management requested IMAC 1,4-dibromobenzene.
August 1, 2010 - IMAC of 70 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

DDE (p,p'-Dichlorodiphenyldichloroethylene) (CASRN 72-55-9)

Health Effects Summary
Human health effects associated with low, oral environmental exposures to DDE are unknown. DDE, a contaminant of DDT (dichlorodiphenyltrichloride), has produced adverse reproductive and developmental effects in male rats including delayed puberty and reproductive system development. Mice and hamsters exposed to DDE via the diet for long durations have developed liver tumors. Thyroid tumors have been reported in rats fed DDE for 78 weeks.

Data used for Groundwater Standard
U.S. EPA's Integrated Risk Information System (IRIS) has not established an oral reference dose (RfD) for DDE (https://www.epa.gov/iris).

U.S. EPA has derived a Provisional Peer-Reviewed Toxicity Value (PPRTV) for DDE. However, a chronic provisional-RfD (p-RfD) was not derived in the PPRTV due to the considerable uncertainty regarding the appropriateness of using the results of perinatal exposure studies to derive a chronic toxicity value. A "screening value" chronic p-RfD of 3 × 10−4 mg/kg-day was provided in the appendix for use in certain, limited instances.

ATSDR has not established a minimum risk level (MRL) for DDE. A systemic threshold concentration cannot be calculated in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA has classified DDE as B2; probable human carcinogen. U.S EPA established a cancer potency factor of 0.34 mg/kg/day for DDE based on liver tumors observed in long-term studies in mice and hamsters and thyroid tumors in female rats (NCI, 1978, U.S.EPA, 1988). A chronic, human drinking water exposure concentration of 0.1µg/L associated with an incremental lifetime cancer risk estimate of 1 x 10^{-6} can be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

No aqueous odor threshold, aqueous taste threshold, federal maximum contaminant level (MCL), or secondary drinking water standard has been established for DDE.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 0.1 µg/L was established under 15A NCAC 02L .0202(c) for DDE in 2010. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for DDE is 0.1 ug/L (ppb) based on its chronic drinking water concentration corresponding to an incremental lifetime cancer risk of 1 x 10^{-6}.

Uses
DDE (p,p'-dichlorodiphenyldichloroethylene) is not commercially produced or used in the United States. It is an impurity and environmental degradation by-product of DDT (dichlorodiphenyltrichloride), an organochlorine pesticide. DDT was banned in the United States in 1972; however it is still used in other countries and may be used in the United States for public health emergencies.

References

Agency for Toxic Substances and Disease Registry. Toxicological Profile for DDT, DDE, and DDD. 2002. http://www.atsdr.cdc.gov/

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

National Cancer Institute (NCI). 1978. Bioassay of DDT, TDE and p,p'-DDE for possible carcinogenicity. NCI Report No. 131. DHEW Publ. No. (NIH) 78-1386.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA Integrated Risk Information System. 1988. IRIS Summary for p,p'-Dichlorodiphenyldichloroethylene (DDE). http://www.epa.gov/iris/ (accessed 10/20/16).

U.S. EPA. Provisional Peer Reviewed Toxicity Values for p,p'- Dichlorodiphenyldichloroethylene (p,p'-DDE) (CASRN 72-55-9). 2017. Office of Research and Development, National Center for Environmental Assessment. https://www.epa.gov/pprtv/provisional-peer-reviewed-toxicity-values-pprtvs-assessments

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/.

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

DDE CASRN 72-55-9

North Carolina Groundwater (GW) Standard = 0.1 µg/L

Summary The North Carolina GW standard for DDE (p,p'-dichlorodiphenyldichloroethylene) is based on a cancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Liver cancer reported in mice and hamsters (long-term feeding studies).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	NA	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	unitless value
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**NA**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	0.34	$(mg/kg\ /day)^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**0.1**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**NA**	**µg/L**
Odor Threshold[7]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[10]

0.03 µg/L

References

[1] NA; US EPA has not established an RfD or p-RfD through its IRIS or PPRTV programs for DDE. No similar toxicity values are available for DDE. Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 10/20/16).

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[5] DDE has been classified B2; probable human carcinogen by EPA. A cancer slope factor of 0.34($mg/kg\text{-}day)^{-1}$ has been calculated by the US EPA (http://www.epa.gov/iris/ accessed 10/20/16).

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[7] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.

[8] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 10/20/16).

[9] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.

[10] PQL provided for informational purposes only. PQL established by North Carolina Water Resources Laboratory under organochlorine pesticides (https://deq.nc.gov/about/divisions/waterresources/water-resources-data/water-sciences-home-page/microbiology-inorganics-branch/methods-pqls-qa).

NA = Not available

History

February 10, 2010 - Request by DWM to establish NC IMAC for DDE.=
August 1, 2010 - IMAC of 0.1 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

DINOSEB (2-(sec-butyl)-4,6-dinitrophenol) (CASRN 88-85-7)

Health Effects Summary
Human health effects associated with low, oral environmental exposures to dinoseb are unknown. Dinoseb is highly toxic in animals and humans following large, acute oral or dermal exposures. Fatigue, thirst, sweating, insomnia, weight loss, headache, flushing of the face, nausea, abdominal pain, diarrhea, and death have been reported in humans exposed to high concentrations of dinoseb.

Rats exposed to dinoseb through the diet for extended periods of time exhibited decreased food intake, decreased body weight, decreased growth and death. Mice and rat offspring born to mothers administered dinoseb via the diet weighed less than control offspring. Decreased fertility, decreased sperm count, increased incidence of abnormal sperm, and birth defects were also reported in animal reproductive/developmental studies with dinoseb.

Data used for Groundwater Standard
U.S. EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.001 mg/kg-day for dinoseb based on decreased fetal weight reported in a 3-generation reproductive study in rats (https://www.epa.gov/iris). A systemic threshold concentration of 7 ug/L (ppb) can be calculated using the oral reference dose for dinoseb in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA has assigned dinoseb to Category D for carcinogenicity (not classifiable as to human carcinogenicity). A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

An aqueous odor threshold, aqueous taste threshold, or secondary drinking water standard is not available for dinoseb. A federal maximum contaminant level (MCL) of 7 µg/L has been established for dinoseb.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 7 µg/L was established under 15A NCAC 02L .0202(c) for dinoseb in 2010. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for dinoseb is 7 ug/L (ppb) based on its Federal Maximum Contaminant Level (MCL) and calculated noncancer systemic threshold.

Uses:
Dinoseb is an herbicide historically used for the selective control of grass and broadleaf weeds. Prior to its discontinuation of use in the United States in 1986, it was used on soybeans, vegetables, fruits and nuts and citrus fruits. Its water soluble ammonium or amine salt forms are less strongly bound to soils and have been detected in groundwater.

References

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA Integrated Risk Information System. 1989. IRIS Summary for Dinoseb. http://www.epa.gov/iris/ (accessed 10/19/16).

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/.

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Dinoseb CASRN 88-85-7

North Carolina Groundwater (GW) Standard = 7 µg/L

Summary The North Carolina GW standard for dinoseb (2-(sec-butyl)-4,6-dinitrophenol) is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Decreased fetal weight (3-generation rat reproductive study).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	1.0E-03	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	unitless value
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**7**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	NA	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**NA**	**µg/L**
Odor Threshold[7]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**7**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[10]

0.6 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 10/17/16). IRIS assessment last revised 8/1/89. Dow Chemical Company. 1981a. MRID No. 00152675. Available from EPA. Write to FOI, EPA, Washington D.C. 20460 (as noted in EPA IRIS Summary for Dinoseb).

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[5] NA; Dinoseb has been classified as a Category D carcinogen (not classificable as to human carcinogenicity) by US EPA. A cancer potency factor has not been established.

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[7] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.

[8] MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 10/17/16).

[9] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.

[10] PQL provided for informational purposes only. PQL established by North Carolina Water Resources Laboratory under acid herbicides. (https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/organic-chemistry-branch/methods-pqls-organics).

NA = Not available

History

February 10, 2010 - Request by DWM to establish NC IMAC for dinoseb.=
August 1, 2010 - IMAC of 7 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

DIPHENYL ETHER (CASRN 101-84-8)

Health Effects Summary
Human health effects associated with low environmental exposures to diphenyl ether (phenyl ether) are unknown. Diphenyl ether is a dermal, respiratory, and ocular irritant. Toxicological data for oral exposures to diphenyl ether are limited to non-published or insufficiently reported research. In a 13-week feeding study, reduced food intake and body weight were observed according to a poorly-reported study referenced by New Jersey Department of Environmental Protection.

Data used for Groundwater Standard
U.S. EPA's Integrated Risk Information System (IRIS) has not established an oral reference dose (RfD) for diphenyl ether.

U.S. EPA has not established a provisional RfD for diphenyl ether. A systemic threshold concentration cannot be calculated for diphenyl ether in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA has not evaluated diphenyl ether for carcinogenicity via oral exposures. A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1 x 10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

An aqueous odor threshold of 180 µg/L has been reported for diphenyl ether (Amoore et al., 1983). No aqueous taste threshold, federal maximum contaminant level (MCL) or secondary drinking water standard is available for diphenyl ether.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 100 µg/L was established under 15A NCAC 02L .0202(c) for diphenyl ether in 2010. This value was based on information included in the New Jersey Groundwater Standard for Diphenyl Ether (2008). There is low confidence in this IMAC given the limited and poorly referenced data available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for diphenyl ether is 180 ug/L (ppb) based on its aqueous odor threshold.

Uses:
Diphenyl ether is used as a heat transfer agent in resins used for laminated electrical insulation and in the manufacture of high-temperature lubricants. It is also used as a fragrance for perfumes, soaps, and detergents and as a chemical intermediate in the manufacture of industrial chemicals.

References
Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

European Commission Recommendation from the Scientific Committee on Occupational Exposure Limits for Diphenyl Ether. 2012.(SCOEL/SUM/182).

New Jersey Department of Environmental Protection. 2008. Groundwater Quality Standard for Diphenyl Ether. Water Monitoring and Standards, Bureau of Water Quality Standards and Assessment. http://www.nj.gov/dep/wms/bears/docs/diphenyl_ether.pdf.

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/.

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Diphenyl ether CASRN 101-84-8

North Carolina Groundwater (GW) Standard = 180 µg/L

Summary The North Carolina GW standard for diphenyl ether (phenyl ether) is based on it aqueous odor threshold in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Aqueous odor threshold (not health-based).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	1.5E-02	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	unitless value
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**105**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	NA	$(mg/kg\ /day)^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	NA	**µg/L**
Odor Threshold (reported for phenyl ether)[7]	180	**µg/L**
Maximum Contaminant Level (MCL)[8]	NA	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	NA	**µg/L**

Practical Quantitation Limit (PQL)[10] 2 µg/L

References

[1] No published RfD, p-RfD or similar toxicity value are available for diphenyl ether. An RfD was derived by the New Jersey Department of Environmental Protecton (NJDEP) based on limited data. There is low confidence in this value given the limited and poorly referenced data available. (http://www.nj.gov/dep/wms/bears/docs/diphenyl_ether.pdf).
[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).
[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).
[4] Average adult water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).
[5] NA; Diphenyl ether has not been evaluated for carcinogenicity. A cancer potency factor is not available.
[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.
[7] Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.
[8] NA;MCL:https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic(accessed11/1/16).
[9] NA;SMCL:https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.
[10] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. PQL from DEQ certified laboratory.

NA = Not available

History

November 8, 2010 - Request by DWM to establish NC IMAC for diphenyl ether.=
April 1, 2011 - IMAC of 100 µg/L approved by DWR Director for diphenyl ether.

Groundwater Standard Summary Document
Division of Water Resources

DIQUAT (1,1'-ethylene-2,2'-bipyridylium dibromide) (CASRN 85-00-7)

Health Effects Summary

Human health effects associated with low, oral environmental exposures to diquat are unknown. Diquat is an eye and skin irritant and has demonstrated toxic effects following dermal exposures in rabbits and rats including decreased food consumption, decreased weight gain, congestion in the lungs, liver, and kidneys, and death. Rats exposed to diquat via the diet in a long-term feeding study exhibited lens opacity and severe cataracts. Cataracts, in addition to decreased adrenal and epididymide weights, were reported in dogs treated with diquat via the diet.

Data used for Groundwater Standard

Note: U.S. EPA reports two RfDs for diquat; one from the EPA IRIS program and one from the Office of Prevention, Pesticides, and Toxic Substances (OPPTS). Although U.S EPA has transferred responsibility for pesticides to OPPTS, it remains unclear which RfD is supported by U.S. EPA. Both values are reported here for completeness.

U.S. EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.0022 mg/kg-day for diquat based on cataracts observed in long-term rat feeding study (https://www.epa.gov/iris). A systemic threshold concentration of 15 µg/L (ppb) can be calculated using the oral reference dose for diquat in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA Office of Prevention, Pesticide, and Toxic Substances (OPPTS) reports an RfD of 0.005 mg/kg-day for diquat dibromide (expressed as diquat cation) based on a 52-week dietary study in dogs (Hopkins, 1990). The critical endpoints were identified as cataracts in female dogs and decreased epididymide and adrenal weights in male dogs. A systemic threshold concentration of 35 µg/L (ppb) can be calculated using the oral reference dose for diquat in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA has assigned diquat to Category E for carcinogenicity (evidence of non-carcinogenicity for humans). A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

An aqueous odor threshold of > 8900 µg/L has been reported (Young et al, 1996). No secondary drinking water standard is not available for diquat. An aqueous taste threshold of 56 µg/L has been reported (Young et al, 1996). A federal maximum contaminant level (MCL) of 20 µg/L has been established for diquat.

Recommended Groundwater Standard

An interim maximum allowable concentration (IMAC) of 20 µg/L was established under 15A NCAC 02L .0202(c) for diquat in 2010. The calculated threshold concentration of 15 µg/L was rounded up to 20 µg/L in accordance with rounding conventions for reporting to one significant figure. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

Groundwater Standard Summary Document
Division of Water Resources

The recommended groundwater standard for diquat is 20 µg/L (ppb) based on its Federal Maximum Contaminant Level (MCL) and calculated noncancer systemic threshold (rounded up from 15 ug/L).

Uses:
Diquat, also referred to as diquat dibromide, is a general use, non-selective herbicide used to control broadleaf and grassy weeds in non-crop areas and surface and underwater weeds in aquatic areas. It is also used as a dessicant on potato crops.

References
Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

Chevron Chemical Company. 1985. MRID No. 00145855, 00155474, 00160673. Available from EPA. Write to FOI, EPA, Washington, DC 20460.

Hopkins, M.N., 1990. Diquat: One year feeding study in dogs. ICI Study No. CTL/P/2596 DPR Vol. 226-094 #089037.

U.S. EPA Integrated Risk Information System. 1987. IRIS Summary for Diquat. http://www.epa.gov/iris/ (accessed 10/19/16).

U.S. EPA Pesticide Registration Summary for Diquat Dibromide. 1995. Office of Prevention, Pesticides and Toxic Substances (EPA-738-F-95-015).

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/.

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Diquat (1,1'-ethylene-2,2'-bipyridylium dibromide) CASRN 85-00-7

North Carolina Groundwater (GW) Standard = 20 µg/L

Summary The North Carolina GW standard for diquat (1,1'-ethylene-2,2'-bipyridylium dibromide) is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Adverse eye effects reported in 2-year rat feeding study (reduced lens opacity and cataracts).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	2.2E-03	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	unitless value
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**15**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	NA	$(mg/kg\ /day)^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**56**	**µg/L**
Odor Threshold[6]	**8900**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**20**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[9]

2 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 10/17/16). IRIS assessment last revised 3/31/87. Chevron Chemical Company. 1985. MRID No. 00145855, 00155474, 00160673. Available from EPA. Write to FOI, EPA, Washington, DC 20460 (as described in EPA IRIS Summary).
[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).
[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).
[4] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).
[5] NA; Diquat has been classified as a Category E carcinogen (evidence of noncarcinogenicity for human) by US EPA according to the 2012 EPA Drinking Water Standards and Health Advisories. A cancer potency factor has not been established.
[6] Young WF, Horth H, Crane R, Ogden T and Arnottt M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.=
[7] MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 10/17/16).
[8] SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.
[9] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. PQL from DEQ certified commercial laboratory.

NA = Not available

History

February 10, 2010 - Request by DWM to establish NC IMAC for diquat.=
August 1, 2010 - IMAC of 20 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

ENDOSULFAN SULFATE (CASRN 1031-07-8)

Health Effects Summary
Human health effects associated with low environmental exposures to endosulfan sulfate are unknown. Endosulfan sulfate is a degradation byproduct of endosulfan. Endosulfan is considered an appropriate structural and toxicological surrogate for endosulfan sulfate.

Endosulfan is an eye irritant. Acute exposures to endosulfan produce neurotoxic effects in animals and humans. Long-term studies in animals exposed via diet to endosulfan reported adverse kidney, liver, lungs, and testes effects. Endosulfan is considered a potential endocrine disruptor.

Data used for Groundwater Standard
U.S. EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.006 mg/kg-day in 1995 for endosulfan based on reduced body weight gain, glomerulonephrosis (changes in kidney membranes), and increased blood vessel aneurysms in rats in a 2-year feeding study. (https://www.epa.gov/iris). A systemic threshold concentration of 42 ug/L (ppb) can be calculated using the oral reference dose for endosulfan in accordance with 15A NCAC 02L .0202(d)(1).

ATSDR (2015) established an intermediate duration Minimum Risk Level (MRL) of 0.005 mg/kg-day for endosulfan and adopted the same value as the chronic duration MRL. A systemic threshold concentration of 35 ug/L (ppb) can be calculated using the chronic MRL for endosulfan and in accordance with 15A NCAC 02L .0202(d)(1). This value is equivalent to the value calculated using the 1995 EPA IRIS RfD for endosulfan when both values are rounded to one significant figure.

U.S. EPA has classified endosulfan as unlikely to be carcinogenic. A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

An aqueous odor threshold, aqueous taste threshold, federal maximum contaminant level (MCL) or secondary drinking water standard have not been established for endosulfan or endosulfan sulfate.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 40 µg/L was established under 15A NCAC 02L .0202(c) for endosulfan sulfate in 2010. ATSDR has published a new chronic duration MRL for endosulfan since the IMAC for endosulfan sulfate was established. The MRL is closely aligned with the 1995 U.S. EPA IRIS RfD for endosulfan and produces a similar groundwater standard when used in the North Carolina groundwater standard calculation.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for endosulfan sulfate is 40 ug/L (ppb) based on its calculated noncancer systemic threshold and using adopted rounding conventions. This value is equivalent to the current groundwater standard for endosulfan.

Uses:
Endosulfan (6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzadioxathiepin 3-oxide) is a chlorinated cyclodiene pesticide broadly used on fruits, vegetables, cereal grains, and cotton in addition to ornamental foliage. Technical grade endosulfan is comprised of its two isomeric forms: alpha-

endosulfan and beta-endosulfan. U.S. EPA phased out use of endosulfan in the United States effective 2016 due to serious adverse health effects including mental retardation, birth defects, and death reported in farmworkers exposed to high concentrations of this pesticide.

References

Agency for Toxic Substances and Disease Registry. Toxicological Profile for Endosulfan. 2015. US Department of Health and Human Services http://www.atsdr.cdc.gov/

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA Integrated Risk Information System. Chemical Assessment Summary for Endosulfan. 2004. http://www.epa.gov/iris (accessed November 8, 2016).

U.S. EPA Provisional Peer Reviewed Toxicity Value for Endosulfan Sulfate. 2013. Office of Research and Development, National Center for Environmental Assessment https://hhpprtv.ornl.gov/quickview/pprtv_papers.php

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/.

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Endosulfan sulfate CASRN 1031-07-8

North Carolina Groundwater (GW) Standard = 40 µg/L

Summary

The North Carolina GW standards for endosulfan and endosulfan sulfate are based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below). Endosulfan is considered an appropriate structural and toxicological surrogate for endosulfan sulfate.
Critical health effect: Reduced body weight gain, glomerulonephrosis (changes in kidney membranes), and increased blood vessel aneurysms in rats (2-year feeding study).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	6.0E-03	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**42**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	NA	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**NA**	**µg/L**
Odor Threshold[7]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[10] Endosulfan sulfate 0.03 **µg/L**

References

[1] Integrated Risk Information System (IRIS) for Endosulfan (http://www.epa.gov/iris/ accessed 11/1/16). IRIS assessment last revised 10/1/1994. Hoechst Celanese Corporation. 1989a. MRID No. 40256502, 41099502. HED Doc. No. 007937. Available from EPA. Write to FOI, EPA, Washington, DC 20460.
EPA Provisional Peer Reviewed Toxicity Values for Endosulfan Sulfate. 2013. (https://hhpprtv.ornl.gov/quickview/pprtv_papers.php). US EPA determined that endosulfan is an appropriate surrogate for endosulfan sulfate.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[5] NA; US EPA has classified endosulfan, and by extension endosulfan sulfate, unlikely to be carcinogenic. Cancer potency factors are not available.

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[7] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.

[8] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic

[9] NA; SMCL: https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

[10] PQL provided for informational purposes only. PQL established by North Carolina Water Resources Laboratory (https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/microbiology-inorganics-branch/methods-pqls-qa)

NA = Not available

History

November 8, 2010 - Request by DWM to establish NC IMAC for endosulfan sulfate.=
April 1, 2011 - IMAC of 40 µg/L approved by DWR Director for endosulfan sulfate.

Groundwater Standard Summary Document
Division of Water Resources

ENDOTHALL (CASRN 145-73-3)

Health Effects Summary
Human health effects associated with low environmental exposures to endothall are unknown. Endothall is a severe skin irritant and a sensitizer. Dogs exposed to endothall via the diet for two years exhibited increased absolute and relative weights of stomach and small intestine compared with controls. An increased incidence of skeletal malformations and variations was reported in rodents fed endothall. In a 2-generation reproductive study, gastric epithelium lesions were reported in rats.

Data used for Groundwater Standard
Note: U.S. EPA reports two RfDs for endothall; one from the EPA IRIS program and one from the Office of Prevention, Pesticides, and Toxic Substances (OPPTS). Although U.S EPA has transferred responsibility for pesticides to OPPTS, it remains unclear which RfD is supported by U.S. EPA. Both values are reported here for completeness.

U.S. EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.02 mg/kg-day for endothall based on increased absolute and relative stomach and small intestine weights reported in a 2-year feeding study in dogs (https://www.epa.gov/iris). A systemic threshold concentration of 140 ug/L (ppb) can be calculated using the oral reference dose for endothall in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA's Office of Prevention, Pesticides, and Toxic Substances (OPPTS) established an oral reference dose (RfD) of 0.007 mg/kg-day in 2005 for endothall based on gastric lesions observed in a 2-generation reproductive study in rats (Trutter, 1993). A systemic threshold concentration of 49 ug/L (ppb) can be calculated using the oral reference dose for endothall in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA has classified endothall as unlikely to be carcinogenic. A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

An aqueous odor threshold, aqueous taste threshold, federal maximum contaminant level (MCL) or secondary drinking water standard is not available for endothall.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 100 µg/L was established under 15A NCAC 02L .0202(c) for endothall in 2010. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

While the OPPTS RfD for endothall is based on a more recent toxicological publication and produces a more conservative groundwater standard, the RfD developed by U.S EPA IRIS is selected as the basis for calculating a North Carolina groundwater standard in accordance with 15A NCAC 02L .0202. Correspondence with U.S. EPA indicated that the IRIS RfD was still considered active and no decision had yet been made with regard to archiving it. The calculated groundwater standard for endothall is rounded down to 100 µg/L in accordance with rounding conventions used to report to one significant figure.

Groundwater Standard Summary Document
Division of Water Resources

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for is 100 ug/L (ppb) based on its calculated noncancer systemic threshold.

Uses:
Endothall is an aquatic herbicide, dessicant, and biocide. It is applied as the dipotassium salt form (2164-07-0) or the N, N-dimethylalkylamine salt form (66330-88-9). Endothall controls submerged aquatic vegetation and algae in lakes, ponds, and irrigation canals. It is also used as a desiccant on potatoes, hops, cotton, clover, and alfalfa. Addition of endothall to cooling towers controls mollusks and algae.

References
Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

Trutter, J. (1993) Two-Generation Reproduction Study in Rats with Disodium Salt of Endothall: Final Report: Lab Project Number: 153/142. Unpublished study prepared by Hazleton Washington, Inc.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA Integrated Risk Information System. Chemical Assessment Summary for Endothall.1987. http://www.epa.gov/iris (accessed November 8, 2016).

U.S. EPA Registration Eligibility Decision (RED) for Endothall. 2005. Office of Prevention, Pesticides, and Toxic Substances. (EPA-738-R-05-008, Case # 2245)

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/.

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Endothall CASRN 145-73-3

North Carolina Groundwater (GW) Standard = 100 µg/L

Summary The North Carolina GW standard for endothall (7-oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid) is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Increased absolute and relative stomach and small intestine weights (2-year feeding study in dogs).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	2.0E-02	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	unitless value
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**140**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	NA	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**NA**	**µg/L**
Odor Threshold[7]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**100**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[10]

10 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 11/2/16). IRIS assessment last revised 3/31/1987. Pennwalt Agchem. 1965. MRID No. 00101735. Available from EPA. Write to FOI, EPA, Washington, DC 20460.
[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).
[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).
[4] Average adult water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).
[5] US EPA has classified endothall as unlikely to be carcinogenic. A cancer slope factor is not available.
[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.
[7] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.
[8] MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic
[9] NA; SMCL: https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals
[10] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. PQL from DEQ certified laboratory.

NA = Not available

History

February 10, 2010 - Request by DWM to establish NC IMAC for endothall.
August 1, 2010 - IMAC of 100 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

<u>Alpha-HEXACHLOROCYCLOHEXANE</u> (CASRN 319-84-6)

Health Effects Summary
Human health effects associated with low environmental exposures to alpha-hexachlorocyclohexane are unknown. Alpha-hexachlorocyclohexane is a potent neurotoxin following acute exposures causing adverse central nervous system effects including excitability, seizures, convulsions, and death. Rats ingesting alpha-hexachlorocyclohexane via the diet for 107 weeks exhibited decreased body weight gain, histopathological changes in the liver and kidneys, and mortality. In long-term animal studies, rats and mice exposed to alpha-hexachlorocyclohexane via the diet developed cancerous liver tumors.

Data used for Groundwater Standard
The Agency for Toxic Substances and Disease Registry (ATSDR), federal health agency for the US Department of Health and Human Services (US DHHS) established a Minimal Risk Level (MRL) of 0.008 mg/kg-day for alpha-hexachlorocyclohexane based on histological changes in the liver of Wistar rats. The hepatic changes included hepatic cell atrophy and fatty degeneration. Non-hepatic effects included decreased body weight gain, slight kidney histopathology and reduced lifespan. A chronic, human drinking water exposure concentration of 56 ug/L (ppb) can be calculated using the oral reference dose (MRL) for alpha-hexachlorocyclohexane in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA classified alpha-hexachlorocyclohexane as a probable human carcinogen according to the 1986 US EPA Cancer Guidelines (Category B2- sufficient evidence in animals and inadequate or no evidence in humans). U.S. EPA established a cancer potency factor of 6.3 mg/kg/day for alpha-hexachlorocyclohexane based on malignant liver tumors observed in long-term studies in mice and rats (U.S EPA, 1987). A chronic, human drinking water exposure concentration of 0.006 µg/L associated with an incremental lifetime cancer risk estimate of 1 x 10^{-6} can be calculated using these data according to the requirements of 15A NCAC 02L .0202(d)(2).

No odor threshold, taste threshold, federal maximum contaminant level (MCL) or secondary drinking water standard has been established for this chemical.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 0.006 µg/L was established under 15A NCAC 02L .0202(c) for alpha-hexachlorocyclohexane in 2011. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the “lesser of” the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for alpha-hexachlorocyclohexane is 0.006 ug/L (ppb) based on the chronic, drinking water concentration corresponding to an incremental lifetime cancer risk of 1 x 10^{-6}.

Uses:
Alpha-hexachlorocyclohexane is not commercially produced or used in the United States. It is one of eight isomers of the organochlorine pesticide, hexachlorocyclohexane (HCH). Technical grade hexachlorocyclohexane, which has not been produced or used in the United States since 1976, is comprised of approximately 64-72% alpha, 11-12% beta, 11-13% gamma, 9% delta and 1-3% epsilon

isomers. The active, insecticidal properties of hexachlorocyclohexane are attributed predominantly to the gamma isomer which is better known as lindane (CAS # 58-89-9). Lindane is still used as a second-alternative treatment for lice and scabies.

References

Agency for Toxic Substances and Disease Registry. Toxicological Profile for Alpha-, Beta-, Gamma-, and Delta-Hexachlorocyclohexane. (Table 2-1; MRL Worksheet, A-3) 2005. http://www.atsdr.cdc.gov/.

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA Integrated Risk Information System. 1987. IRIS Summary for Alpha-Hexachlorocyclohexane (Alpha-HCH). http://www.epa.gov/iris (accessed November 14, 2016).

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

alpha-Hexachlorocyclohexane CASRN 319-84-6

North Carolina Groundwater (GW) Standard = 0.006 µg/L

Summary

The North Carolina GW standard for alpha-hexachlorocyclohexane# is based on a cancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Liver tumors in mice and rats (24-72 week feeding studies).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	8.0E-03	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	unitless value
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**56**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	6.3	$(mg/kg\ /day)^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**0.006**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**NA**	**µg/L**
Odor Threshold[7]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[10]

0.0013 µg/L

References

[1] Agency for Toxic Substances and Disease Control (ATSDR) Toxicological Profile for Alpha-, Beta-, Gamma- and Delta-Hexachlorocyclohexane. 2005. Fitzhugh OG, Nelson AA, Frawley JP. 1950. The chronic toxicities of technical benzene hexachloride and its α, β and γ isomers. J Pharmacol Exp Ther 100:59-66.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] Average adult water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[5] Alpha-hexachlorocyclohexane has been classified as a Category B2 carcinogen (probable human carcinogen) by US EPA according to its 1986 Guidelines for Carcinogen Risk Assessment. Classification based on five animal studies described in the IRIS Summary Document. Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 11/14/16). IRIS assessment last revised 3/31/1987.

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[7] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.

[8] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic

[9] NA; SMCL: https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

[10] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. PQL from DEQ certified commercial laboratory.

NA = Not available

#- Synonyms include alpha-BHC and alpha-HCH.

History

May 18, 2010 - Request by DWM to establish NC IMAC for alpha-hexachlorocyclohexane.=
April 1, 2011 - IMAC of 0.006 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

Beta-HEXACHLOROCYCLOHEXANE (CASRN 319-85-7)

Health Effects Summary

Human health effects associated with low environmental exposures to beta-hexachlorocyclohexane are unknown. Beta-hexachlorocyclohexane may be absorbed through the skin. Beta-hexachlorocyclohexane is a potent neurotoxin following acute exposures causing adverse central nervous system effects including excitability, seizures, convulsions, and death. Beta-hexachlorocyclohexane has a longer half-life compared with other hexachlorocyclohexane isomers and therefore is retained longer in human fat tissue and blood.

In animal studies, ingestion of beta-hexachlorocyclohexane was linked with adverse male and female reproductive effects. Structural changes in seminferous tubules and testicular atrophy were reported in male rats and mice while ovarian atrophy, increased estrous cycle length, and decreased ovulation rate were reported in female rats, mice, and rabbits. Liver tumors were observed in long-term studies in mice and rats exposed to beta-hexachlorocyclohexane via the diet.

Data used for Groundwater Standard

U.S. EPA's Integrated Risk Information System (IRIS) has not established an oral reference dose (RfD) for beta-hexachlorocyclohexane (https://www.epa.gov/iris).

U.S. EPA has not established a provisional chronic oral p-RfD for beta-hexachlorocyclohexane through its PPRTV program. (https://hhpprtv.ornl.gov/quickview/pprtv_papers.php). ATSDR has not established a minimum risk level (MRL) for beta-hexachlorocyclohexane. A systemic threshold concentration cannot be calculated in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA classified beta-hexachlorocyclohexane as a Category C carcinogen (possible human carcinogen) according to the 1986 US EPA Cancer Guidelines. U.S. EPA established a cancer potency factor of 1.8 mg/kg/day for beta-hexachlorocyclohexane based on benign liver tumors observed in long-term studies in mice and rats (U.S EPA, 1987). A chronic, human drinking water exposure concentration of 0.02 µg/L associated with an incremental lifetime cancer risk estimate of 1×10^{-6} can be calculated using these data according to the requirements of 15A NCAC 02L .0202(d)(2).

No odor threshold, taste threshold, federal maximum contaminant level (MCL) or secondary drinking water standard has been established for this chemical.

Recommended Groundwater Standard

An interim maximum allowable concentration (IMAC) of 0.02 µg/L was established under 15A NCAC 02L .0202(c) for beta-hexachlorocyclohexane in 2011. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for beta-hexachlorocyclohexane is 0.02 ug/L (ppb) based on the chronic, drinking water concentration corresponding to an incremental lifetime cancer risk of 1×10^{-6}.

Groundwater Standard Summary Document
Division of Water Resources

Uses:

Beta-hexachlorocyclohexane is not commercially produced or used in the United States. It is one of eight isomers of the organochlorine pesticide, hexachlorocyclohexane (HCH). Technical grade hexachlorocyclohexane, which has not been produced or used in the United States since 1976, is comprised of approximately 64-72% alpha, 11-12% beta, 11-13% gamma, 9% delta and 1-3% epsilon isomers. The active, insecticidal properties of hexachlorocyclohexane are attributed predominantly to the gamma isomer which is better known as lindane (CAS # 58-89-9). Lindane is still used as a secondary-alternative treatment for lice and scabies.

References

Agency for Toxic Substances and Disease Registry. Toxicological Profile for Alpha-, Beta-, Gamma-, and Delta-Hexachlorocyclohexane. 2005. http://www.atsdr.cdc.gov/.

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA Integrated Risk Information System. 1987. IRIS Summary for Beta-Hexachlorocyclohexane (Beta-HCH). http://www.epa.gov/iris (accessed November 14, 2016).

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

beta-Hexachlorocyclohexane CASRN 319-85-7

North Carolina Groundwater (GW) Standard = 0.02 µg/L

Summary

The North Carolina GW standard for beta-hexachlorocyclohexane# is based on a cancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Benign liver tumors in mice (110 week feeding study).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	NA	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	unitless value
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**NA**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	1.8	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**0.02**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**NA**	**µg/L**
Odor Threshold[7]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[10]

0.0013 µg/L

References

[1] NA; US EPA has not established an RfD or p-RfD through its IRIS or PPRTV programs for beta-hexachlorocyclohexane. ATSDR established an intermediate MRL for beta-hexachlorocyclohexane but not a chronic one. Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 11/14/16). IRIS assessment last revised 9/30/1987.
[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).
[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).
[4] Average adult water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).
[5] Beta-hexachlorocyclohexane has been classified as a Category C carcinogen (possible human carcinogen) by US EPA according to its 1986 Guidelines for Carcinogen Risk Assessment. Thorpe, E. and A.I.T. Walker. 1973. Toxicology of dieldrin (HEOD). II. Comparative long-term oral toxicity studies in mice with dieldrin, DDT, phenobarbitone, beta-HCH and gamma-HCH. Food Cosmet. Toxicol. 11: 433-442.
[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.
[7] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.
[8] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic
[9] NA; SMCL: https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals
[10] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. PQL from DEQ certified commercial laboratory.

NA = Not available
#- Synonyms include beta-BHC and beta-HCH.

History

May 18, 2010 - Request by DWM to establish NC IMAC for beta-hexachlorocyclohexane.=
April 1, 2011 - IMAC of 0.02 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

p-ISOPROPYLTOLUENE (p-cymene) (CASRN 99-87-6)

Health Effects Summary
Human health effects associated with low, oral environmental exposures to p-isopropyltoluene are unknown. Toxicological data for oral exposures to p-isopropyltoluene are limited to a single acute study. Rats gavaged with high doses of p-isopropyltoluene exhibited CNS symptoms including intoxication, depression,tremor, lethargy, and muscular weakness. p-Isopropyltoluene is considered to be a skin irritant.

Data used for Groundwater Standard
U.S. EPA's Integrated Risk Information System (IRIS) has not established an oral reference dose (RfD) for p-isopropyltoluene.

U.S. EPA has not established a provisional RfD for p-isopropyltoluene. A systemic threshold concentration cannot be calculated for p-isopropyltoluene in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA has not evaluated p-isopropyltoluene for carcinogenicity via oral exposures. A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1 x 10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

An aqueous odor threshold of 25 µg/L has been reported for p-isopropyltoluene (Young et al., 1996). No taste threshold, federal maximum contaminant level or secondary drinking water standard has been established.

Note: Isopropylbenzene was identified as a structural surrogate for the purpose of deriving an RfD by Brewster Environmental, the original requester of the IMAC. A summary of the rationale and process used to propose an IMAC of 70 µg/L for p-isoproylbenzene is included as Attachment 1. This information was presented to the North Carolina Groundwater Committee on May 11, 2011. Given that the adopted IMAC for p-isopropyltoluene was based on its aqueous odor threshold, the surrogate information is not further described here.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 25 µg/L was established under 15A NCAC 02L .0202(c) for p-isopropyltoluene in 2010. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for p-isopropyltoluene is 25 µg/L (ppb) based on its aqueous odor threshold.

Use
P-isopropyltoluene is a food flavoring agent considered to be "generally recognized as safe" (GRAS by the Flavor and Extract Manufacturers Association). It is a naturally occurring substance found in butter, carrots, nutmeg, orange juice, oregano, raspberries and lemon oil. It is also used as a solvent for dyes and

varnishes, a heat transfer
medium, an additive in fragrances and musk perfumes, and as a masking odor for industrial products.

References

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA Office of Pollution Prevention and Toxics. 2005. High Production Volume (HPV) Challenge Program's Robust Summaries and Test Plans. Robust Summaries for Aromatic Terpene Hydrocarbons (p-Cymene; CAS No. 99-87-6) (Document 201-15924A). http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.523.7497&rep=rep1&type=pdf

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/.

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

Groundwater Standard Summary Document
Division of Water Resources

Attachment 1
Presented to North Carolina Groundwater Committee May 11, 2011

4-Isopropyltoluene IMAC Development

Why was an IMAC requested?

An IMAC for 4-isopropyltoluene was requested by both Brewster Environmental and the Division of Waste Management (DWM). Brewster Environmental requested the IMAC on behalf of a client who is seeking to close an old groundwater contamination site (1998) that has been transferred to the DWM Inactive Sites Program. The source was removed in 1998 and 4-isopropyltoluene is the only substance currently detected in groundwater (0.63 ug/L). The establishment of an IMAC could enable the DWM to close the site and save the responsible party future monitoring cost.

4-isopropyltoluene is used as a solvent for dyes and varnishes, as a heat transfer medium, as a food additive, an additive in fragrances and musk perfumes, and as a masking odor for industrial products.

Why was a surrogate chemical used to develop the IMAC?

Toxicity indices (Reference Dose and Cancer Potency Factor) for 4-isopropyltoluene were not found in the peer-reviewed literature; therefore, Brewster Environmental used isopropylbenzene as a structural surrogate in the same chemical family (alky benzenes) to calculate a proposed IMAC of 70 ug/L.

Chemicals belonging to the same chemical family often have similar properties and toxicity. USEPA uses quantitative structure-toxicity relationships (QSTRs) to assess the health effects of chemicals of concern at Superfund and hazardous waste sites when there is a lack of experimental toxicity data in the literature. QSTR techniques assume that a relationship between the toxicity of a chemical and its structure exists.

Isopropylbenzene was chosen as a structural surrogate for 4-isopropyltolune based on the following similarities in:

- Physical and chemical characteristics, such as molecular weight, density, melting point, boiling point, water solubility, vapor pressure;
- Structural characteristics :both are six-membered ring aromatic compounds with substituted alkyl groups;
- Metabolic pathway and classes of metabolites (alcohols and conjugates readily excreted by humans).

Maine and New Hampshire used isopropylbenzene as a structural surrogate for 4-isopropyltoluene to establish groundwater standards of 70 ug/L and 260 ug/L, respectively. Maine used a safety factor of 10 to be conservative, while New Hampshire did not use a safety factor.

The table below highlights the similarity in the range of toxicity for alkyl benzenes that have 2L groundwater standards or IMACs.

Groundwater Standard Summary Document
Division of Water Resources

Attachment 1
Presented to North Carolina Groundwater Committee May 11, 2011

Substance	2L Standard or IMAC ug/L (ppb)
4-isopropyltoluene	25
isopropylbenzene	70
n-propylbenzene	70
toluene	600
1,2,4-trimethylbenzene	400
1,3,5-trimethylbenzene	400
xylene	500

Is the use of a safety factor of 10 adequate?

A safety factor of 10 was applied to the USEPA IRIS reference dose of 0.1 mg/kg/day for isopropylbenzene to account for its use as a structural surrogate for 4-isopropyltoluene. The safety factor is considered adequate because the surrogate, isopropylbenzene, represents one of the more toxic alkyl benzenes for which toxicity information is available and is the most similar in structure to 4-isopropyltoluene.

The systematic threshold concentration for 4-isopropyltoluene was calculated according to the 2L .0202(c)(1) as follows:

[Reference Dose (mg/kg/day) x 70 kg (adult body weight) x Relative Source Contribution (.20 for organics)] / [2 liters/day (ave. water consumption)]

[0.01 mg/kg-day x 70 kg x 0.20] / [2 L/day] = 70 ug/L

Is the odor threshold that was ultimately used to establish the IMAC protective of potential health effects that may occur from exposure to 4-isoproplybenzene?

Because the odor threshold of 25 ug/L for 4-isopropyltoluene is lower than the calculated systemic threshold concentration of 70 ug/L, the use of the odor threshold as the IMAC is considered protective of potential health effects that may arise from exposure to this substance. In addition, the odor threshold of 70 ug/L for isopropylbenzene, the surrogate used for 4-isopropyltoluene, is the same as the calculated systemic threshold concentration for 4-isopropyltoluene.

North Carolina Groundwater Standard Calculation Sheet

p-Isopropyltoluene (p-cymene) CASRN 99-87-6

North Carolina Groundwater (GW) Standard = 25 µg/L

Summary

The North Carolina GW standard for p-isopropyltoluene is based on its aqueous odor threshold in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: None identified due to lack of data. Groundwater standard is not health-based.

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	1.00E-02	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.2	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**70**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**25**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[9]

1 µg/L

References

[1] No published RfD, p-RfD or similar toxicity values are available for p-isopropyltoluene. An RfD was derived by Brewster Environmental Consulting using isopropylbenzene as a structural and toxicological surrogate for p-isopropyltoluene. Details are provided in Attachment 1.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] NA; P-Isopropyltoluene has not been evaluated for carcinogenicity. A cancer potency factor is not available.

[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[6] Young WF, Horth H, Crane R, Ogden T and Arnottt M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-[7] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 7/26/2016)

[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

[9] PQL provided for informational purposes only. PQL established by North Carolina Water Resources Laboratory.

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

November 8, 2010 - Request by Brewster Environmental and DWM to establish NC IMAC for p-isopropytoluene. April 1, 2011 - IMAC of 25 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

METHL BUTYL KETONE (2-Hexanone) (CASRN 591-78-6)

Health Effects Summary
Human health effects associated with low, oral environmental exposures to 2-hexanone are unknown. 2-Hexanone produces neurotoxic effects in humans and animals via inhalation. Animals receiving oral doses of 2-hexanone exhibited mild weakness, hindlimb paralysis, and abnormal pupil responses to light. Animals dosed orally or dermally with 2,5-hexanedione, a metabolite of 2-hexanone, exhibited severe neurological effects.

Data used for Groundwater Standard
US EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.005 mg/kg-day for 2-hexanone based on a 13-month drinking water study in rats (http://www.epa.gov/iris/). A systemic threshold concentration of 35 µg/L (ppb) can be calculated using the oral reference dose for 2-hexanone in accordance with 15A NCAC 02L .0202(d)(1).

US EPA has not classified 2-hexanone for carcinogenicity. A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1 x 10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

An odor threshold of 250 µg/L has been reported for 2-hexanone in aqueous solutions (Amoore and Hautala, 1983). A taste threshold, federal maximum contaminant level or secondary drinking water standard has not been established for 2-hexanone.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 40 µg/L was established under 15A NCAC 02L .0202(c) for 2-hexanone in 2010. The calculated threshold concentration of 35 µg/L was rounded up to 40 µg/L in accordance with rounding conventions. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for 2-hexanone is 40 ug/L (ppb) based on the calculated noncancer systemic threshold.

Uses:
2-Hexanone is no longer manufactured in the United States and its uses have been restricted. It had been used in paint, paint thinners, and lacquer solvents. It is formed as a waste product of wood pulping, coal gasification, and oil shale operations.

References
Agency for Toxic Substances and Disease Registry. Toxicological Profile for 2-Hexanone. 1992. http://www.atsdr.cdc.gov/.

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA Integrated Risk Information System. 2009. Chemical Assessment Summary for 2-Hexanone http://www.epa.gov/iris (accessed 7/20/16).

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/.

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Methyl Butyl Ketone (2-Hexanone) CASRN 591-78-6

North Carolina Groundwater (GW) Standard = 40 µg/L

Summary

The North Carolina GW standard for methyl butyl ketone is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Neurotoxicity (axonal swelling of peripheral nerve in 13-month drinking water study in rats).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	5.00E-03	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.2	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**35**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	$(mg/kg\ /day)^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**250**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[9]

5 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 7/20/16). IRIS assessment last revised 9/25/09. O'Donoghue, JL; Krasavage, WJ; Terhaar, CJ. (1978) A comparative chronic toxicity study of methyl n-propyl ketone, methyl n-butyl ketone, and hexane by ingestion. Eastman Kodak Company, Rochester, NY; Report No. 104657Y. Submitted under TSCA Section 8ECP; EPA Document No. 88-920008233; NTIS No. OTS0555051.
[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).
[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).
[4] NA; Methyl butyl ketone has not been classified by EPA for carcinogenicity. A cancer potency factor is not available.
[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.
[6] Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.
[7] NA;MCL:https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic(accessed7/20/16)
[8] NA;SMCL:https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals
[9] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. PQL from DEQ certified commercial laboratory.

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

November 2010 - Division of Waste Management requested IMAC for 2-hexanone.=
April 1, 2011 - IMAC of 40 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

METHYL ISOBUTYL KETONE (4-methyl-2-pentanone) (CASRN 108-10-1)

Health Effects Summary
Human health effects associated with low environmental exposures to methyl isobutyl ketone are unknown. There are limited toxicological data available for oral exposures to methyl isobutyl ketone with only two animal studies located: a 13-week gavage study and 90-day drinking water study in rats. Increased kidney and liver weights and general nephropathy were reported in these studies.

Data used for Groundwater Standard
U.S. EPA's Integrated Risk Information System (IRIS) withdrew its oral reference dose (RfD) for methyl isobutyl ketone in 1991 and replaced it with a "qualitative discussion". U.S. EPA determined there were inadequate toxicological data to derive an oral RfD.

A provisional oral reference dose (p-RfD) has not been established for methyl isobutyl ketone.

California established a notification level of 120 µg/L for methyl isobutyl ketone in drinking water in 1999. This value was based on a correction to the NOAEL identified in the 1997 HEAST table because the NOAEL cited in the HEAST table was a misprint. California used a corrected NOAEL of 50 mg/kg-day and an uncertainty factor of 3000 (10 for animal to human extrapolation, 10 for human variability, 10 for use of a subchronic study, and 3 for database deficiencies) to derive an oral RfD of 0.017 mg/kg-day. A systemic threshold concentration of 120 ug/L (ppb) can be calculated using the oral reference dose for methyl isobutyl ketone in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA has not classified methyl isobutyl ketone for carcinogenicity. A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

An aqueous odor threshold of 1,300 µg/L has been reported for methyl isobutyl ketone (Amoore et al., 1983). No taste threshold, federal maximum contaminant level (MCL) or secondary drinking water standard has been established for methyl isobutyl ketone.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 100 µg/L was established under 15A NCAC 02L .0202(c) for methyl isobutyl ketone in 2010. The calculated threshold concentration of 120 µg/L was rounded down to 100 µg/L in accordance with rounding conventions. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for methyl isobutyl ketone is 100 ug/L (ppb) based on the calculated noncancer systemic threshold.

Uses
Methyl isobutyl ketone is widely used as a solvent in cosmetic and pharmaceutical products. It is also used as a solvent for resins, paints, lacquers, and varnishes. It is used in the semiconductor industry and as an indirect food additive for adhesives, papers, and polymers holding food products. Methyl isobutyl

ketone is used in the production of rubber compounds for tire manufacturing and as a denaturant for alcohol.

References

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

California EPA Office of Environmental Health Hazard Assessment. Memorandum on Proposed Notification Level for Methyl Isobutyl Ketone from George Alexeeff (Deputy Director for Scientific Affairs) to David P. Spath (Chief of Division of Drinking Water and Environmental Management Branch) December 29, 1999.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA Integrated Risk Information System. Chemical Assessment Summary for Methyl Isobutyl Ketone. 2003. http://www.epa.gov/iris (accessed August 8, 2016).

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Methyl Isobutyl Ketone (4-methyl-2-pentanone) CASRN 108-10-1

North Carolina Groundwater (GW) Standard = 100 µg/L

Summary

The North Carolina GW standard for methyl isobutyl ketone is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202.
Critical health effect: Increased relative kidney and liver weights and general nephropathy (13-week study in rats).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	1.70E-02	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.2	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**119**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	$(mg/kg/day)^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**1,300**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[9]

10 µg/L

References

[1] Recalculated HEAST-reported RfD based on NOAEL of 50 mg/kg-day and composite uncertainty factor of 3000 (10 for interspecies, 10 for human variability, 10 for use of subchronic study, and 3 for database limitations). NOAEL misreported in HEAST table according to Cal EPA. Cal EPA has established a notification level of 120 µg/L for methyl isobutyl ketone. http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/Documents/Notificationlevels/notificationlevels.pdf

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] NA; US EPA determined there was inadequate information to assess the carcinogenic potential of methyl isobutyl ketone. A cancer potency factor is not available.

[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[6] Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

[7] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 7/20/16)

[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

[9] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. PQL from NC DEQ certified commercial laboratory.
NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

April 27, 2010 - Division of Waste Management requested IMAC for methyl isobutyl ketone (MIBK).=
December 1, 2010 - IMAC of 100 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

METHYL METHACRYLATE (CASRN 80-62-6)

Health Effects Summary

Human health effects associated with low environmental exposures to methyl methacrylate are unknown. Methyl methacrylate has a distinctive, fruity smell and its vapor may cause irritation of the eyes, nose, throat, and respiratory tract. Methyl methacrylate is a dermal sensitizer.

CNS effects were reported in rats exposed to high doses (500 mg/kg-day) of methyl methacrylate for 3-weeks by gavage. There are few chronic studies evaluating the effects of ingested methyl methacrylate. Decreased water consumption and increased relative kidney weight (females only) was reported in a 2-year drinking water study in rats. No treatment-related effects were reported in a 2-year feeding study in dogs. No evidence of carcinogenic effects have been reported in rats or mice exposed to methyl methacrylate via inhalation in long-term studies. Methyl methacrylate has been not evaluated for carcinogenicity via the oral route; however EPA considers methyl methacrylate unlikely to be carcinogenic via any route of exposure (EPA IRIS, 1988).

Data used for Groundwater Standard

U.S. EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 1.4 mg/kg-day for methyl methacrylate based on a 2-year drinking water study in rats. A systemic threshold concentration of 9800 ug/L (ppb) can be calculated using the oral reference dose for methyl methacrylate in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA has not evaluated methyl methacrylate for carcinogenicity via oral exposures. A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1 x 10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

An aqueous odor threshold of 25 µg/L has been reported for methyl methacrylate (Amoore et al., 1983). No aqueous taste threshold, federal maximum contaminant level (MCL) or secondary drinking water standard is available for methyl methacrylate.

Recommended Groundwater Standard

An interim maximum allowable concentration (IMAC) of 25 µg/L was established under 15A NCAC 02L .0202(c) methyl methacrylate in 2010. This value was based on its reported aqueous odor threshold (Amoore et al., 1983).

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for methyl methacrylate is 25 ug/L (ppb) based on its aqueous odor threshold.

Uses

Methyl methacrylate (monomer) is a clear liquid that contains small amounts of inhibitor (hydroquinone, hydroquinone methyl ether, or dimethyl tert-butylphenol) to prevent spontaneous polymerization. Methyl methacrylate polymers and copolymers are produced industrially and used in acrylic sheets, clear plastics, extrusion powders, latex paints, adhesive cement; and floor polishes.

Groundwater Standard Summary Document
Division of Water Resources

References

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

Dow Chemical Company Product Safety Assessment for Methyl Methacrylate Monomer. Accessed December 1, 2016 (www.dow.com/productsafety/finder/).

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA Integrated Risk Information System. 1988. Chemical Assessment Summary for Methyl Methacrylate. http://www.epa.gov/iris (accessed December 1, 2016).

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/.

World Health Organization Concise International Chemical Assessment Document 4: Methyl Methacrylate. 1998. Geneva, Switzerland.

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Methyl methacrylate CASRN 80-62-6

North Carolina Groundwater (GW) Standard = 25 µg/L

Summary The North Carolina GW standard for methyl methacrylate is based on its aqueous odor threshold in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Aqueous odor threshold (not health-based).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	1.4E+00	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	unitless value
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**9800**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	NA	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**NA**	**µg/L**
Odor Threshold[7]	**25**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[10] 2 µg/L

References

[1] Integrated Risk Information System (IRIS) for Methyl methacrylate (http://www.epa.gov/iris/ accessed 12/1/16). IRIS assessment last revised 3/2/1988. Borzelleca, JF; Larson, PS; Hennigar, GR, Jr; Huf, EG; Crawford, EM; Smith, RB, Jr., (1964) Studies on the chronic oral toxicity of monomeric ethyl acrylate and methyl methacrylate. Toxicol. Appl. Pharmacol. 6:29-36.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] Average adult water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[5] NA; US EPA classified methyl methacrylate as Category E for carcinogenicity (evidence of non-carcinogenicity for humans) according to the US EPA 1986 guidelines for Carcinogen Risk Assessment. A cancer potency factor is not available.

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[7] Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

[8] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 12/1/16).

[9] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.

[10] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. PQL from NC DEQ certified commercial laboratory.

NA = Not available

History

February 10, 2010 - Request by DWM to establish NC IMAC for methyl methacrylate.=
August 1, 2010 - IMAC of 25 µg/L approved by DWR Director for methyl methacrylate.

Groundwater Standard Summary Document
Division of Water Resources

1-METHYLNAPTHALENE (CASRN 90-12-0)

Health Effects Summary
Human health effects associated with low environmental exposures to 1-methylnapthalene are unknown. There are limited toxicological data available for oral exposures to 1-methylnapthalene with only a single animal study located. Mice exposed to 1-methylnapthalene in the diet for 81-weeks exhibited lung tumors. The high incidence of similar tumors in control mice suggests that animals were concurrently exposed via inhalation to 1-methylnapthalene vaporized from the dietary feed.

Data used for Groundwater Standards
US EPA's Integrated Risk Information System (IRIS) has not established an oral reference dose (RfD) for 1-methylnapthalene.

US EPA has not established a provisional RfD for 1-methylnapthalene. A systemic threshold concentration cannot be calculated for 1-methylnapthalene in accordance with 15A NCAC 02L .0202(d)(1).

US EPA established a provisional cancer potency factor of 0.029 mg/kg-day for 1-methylnapthalene based on lung tumors observed in an 81-week feeding study in mice. This study provides "Suggestive Evidence of Carcinogenicity" in accordance with current U.S. EPA (2005) carcinogen risk assessment guidelines. A human exposure concentration of 1 µg/L associated with an incremental lifetime cancer risk estimate of 1 x 10^{-6} can be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

ATSDR derived a chronic Maximum Risk level (MRL) of 0.07 mg/kg-day for 1-methylnapthalene. They also cite an odor threshold in aqueous solutions of 7.5 µg/L for 1-methylnapthalene.

No taste threshold, federal maximum contaminant level or secondary drinking water standard has been established for 1-methylnapthalene.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 1 µg/L was established under 15A NCAC 02L .0202(c) for 1-methylnapthalene in 2011. This value was calculated from a provisional cancer slope factor based on lung tumors in a feeding study in mice. There is low confidence in the slope factor since a 10% incidence of similar lung tumors was observed in the control group. This suggests that vaporized 1-methylnapthalene from the feed was inhaled by the mice and may have contributed to or caused the lung tumors.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for 1-methylnapthalene is 1 ug/L (ppb) based on the concentration corresponding to an incremental lifetime cancer risk of 1 x 10^{-6}.

Uses
1-Methylnaphthalene is used in the synthesis of 1-methylnaphthoic acid. It is also used as a dyeing agent and as a test substance for determining the ignition capability of diesel fuels.

Groundwater Standard Summary Document
Division of Water Resources

References

Agency for Toxic Substances and Disease Registry. Toxicological Profile for Napthalene, 1-Methylnapthalene, and 2-Methylnapthalene. 2005. US Department of Health and Human Services http://www.atsdr.cdc.gov/

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA Provisional Peer Reviewed Toxicity Value for 1-Methylnapthalene. 2008. Office of Research and Development, National Center for Environmental Assessment https://hhpprtv.ornl.gov/quickview/pprtv_papers.php

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

1-Methylnapthalene CASRN 90-12-0

North Carolina Groundwater (GW) Standard = 1 µg/L

Summary

The North Carolina GW standard for 1-methylnapthalene is based on a cancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Lung tumors in male mice (81-week study).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	7.00E-02	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution	0.2	unitless value
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**490**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	0.029	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**1.2**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**7.5**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[9]

0.5 µg/L

References

[1] An RfD or provisonal RfD is not available. A screening value was proposed in EPA Provisional Peer Reviewed Toxicity Values for 1-methylnapthalene. However, a screening value is not appropriate to use to calculate a groundwater standard due to its large uncertainty. ATSDR derived a chronic MRL for 1-methylnapthalene based on pulmonary alveolear proteinosis reported in an 81-week mouse study. Murata, Y., A. Denda, H. Maruyama and Y. Konishi. 1993. Chronic toxicity and carcinogenicity studies of 1-methylnaphthalene in B6C3F1 mice. Fund. Appl. Toxicol. 21:44-51.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] A provisional human oral slope factor was derived by US EPA Provisional Peer Reviewed Toxicity Values for 1-methylnapthalene. 2009.
Murata, Y., A. Denda, H. Maruyama and Y. Konishi. 1993. Chronic toxicity and carcinogenicity studies of 1-methylnaphthalene in B6C3F1 mice.
Fund. Appl. Toxicol. 21:44-51.

[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[6] Agency for Toxic Substances and Disease Control. 2005. Toxicological Profile for napthalene, 1-methylnapthalene, and 2-napthalene.

[7] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 7/21/2016)

[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

[9] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. PQL from NC DEQ certified commercial laboratory.

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

November 8, 2010 - Request by DWM to establish NC IMAC for 1-methylnapthalene.
April 1, 2011 - IMAC of 1 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

2-METHYLPHENOL (o-Cresol) (CASRN 95-48-7)

Health Effects Summary

Human health effects associated with low environmental exposures to 2-methylphenol (o-cresol) are unknown. 2-Methylphenol is a severe skin and eye irritant and is rapidly absorbed through the skin. Rats gavaged with 2-methylphenol for 90 days exhibited decreased food consumption and body weight, CNS effects including lethargy, tremor, lacrimation, eyelid closing, convulsions, and coma, increased kidney to body weight ratio, and increased mortality. 2-Methylphenol produced maternal toxicity and fetotoxicity in rats and rabbits. Development effects were reported in rats at maternally toxic doses. No developmental effects were reported in rabbits. 2-Methylphenol produced dermal papillomas (benign epithelial tumors) in dermal mouse studies; oral studies assessing the carcinogenicity of 2-methylphenol have not been conducted.

Data used for Groundwater Standard

U.S. EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.05 mg/kg-day for 2-methylphenol based on decreased body weights and neurotoxic effects reported in a 90-day gavage study in rats (http://www.epa.gov/iris/). A systemic threshold concentration of 350 µg/L can be calculated using the oral reference dose for 2-methylphenol in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA has not evaluated 2-methylphenol for carcinogenicity via the oral route of exposure. Cancer studies evaluating the potential dermal carcinogenicity of 2-methylphenol have been conducted. U.S. EPA has classified 2-methylphenol as Category C (possible human carcinogen) based on skin papillomas reported in dermal mouse studies. A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

No aqueous odor threshold, aqueous taste threshold, federal maximum contaminant level (MCL) or secondary drinking water standard has been established for 2-methylphenol.

Recommended Groundwater Standard

An interim maximum allowable concentration (IMAC) of 400 µg/L was established under 15A NCAC 02L .0202(c) for 2-methylphenol in 2010. The calculated threshold concentration of 350 µg/L was rounded up to 400 µg/L in accordance with rounding conventions for reporting to one significant figure. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for 2-methylphenol is 400 ug/L (ppb) based on the calculated noncancer systemic threshold.

Uses

2-Methylphenol is used predominantly as a solvent, a disinfectant, or a component of cleaning agents. It is used as an intermediate in the synthesis of pharmaceuticals, pesticides, dyes, and epoxy resins.

References

Agency for Toxic Substances and Disease Control. 2008. Toxicological Profile for Cresols. U.S. Department of Health and Human Services. (https://www.atsdr.cdc.gov/toxprofiles/index.asp)

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA Integrated Risk Information System. Chemical Assessment Summary for 2-Methylphenol. 1988. http://www.epa.gov/iris (accessed December 5, 2016).

U.S. EPA. 1986. o, m, p-Cresol. 90-Day oral subchronic toxicity studies in rats. Office of Solid Waste, Washington, DC.

U.S. EPA. 1987. o, m, p-Cresol. 90-Day oral subchronic neurotoxicity study in rats. Office of Solid Waste, Washington, DC.

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

2-Methylphenol (o-Cresol) CASRN 95-48-7

North Carolina Groundwater (GW) Standard = 400 µg/L

Summary

The North Carolina GW standard for 2-methylphenol is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Neurotoxic effects and decreased body weights (90-day rat gavage study).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	5.0E-02	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	unitless value
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**350**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	NA	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**NA**	**µg/L**
Odor Threshold[7]	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[10]

10 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 12/2/16). IRIS assessment last revised 9/7/88. U.S. EPA. 1986. o, m, p-Cresol. 90-Day oral subchronic toxicity studies in rats. Office of Solid Waste, Washington, DC.
U.S. EPA. 1987. o, m, p-Cresol. 90-Day oral subchronic neurotoxicity study in rats. Office of Solid Waste, Washington, DC.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] Average adult water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[5] NA; 2-Methylphenol has been classified as a Category C carcinogen (possible human carcinogen) by US EPA based on skin papillomas observed in a dermal mouse study. It is unknown if such effects are relevant for oral exposures to 2-methylphenol. A cancer potency factor has not been established.

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[7] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.

[8] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 12/2/16).

[9] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.

[10] PQL provided for informational purposes only. PQL established by North Carolina Water Resources Laboratory under semivolatiles. (https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/organic-chemistry-branch/methods-pqls-organics).

NA = Not available

History

November 2010 - Division of Waste Management requested IMAC for 2-methylphenol.
April 1, 2011 - IMAC of 400 µg/L approved by DWR Director.

Groundwater Standard Summary Document
Division of Water Resources

PERFLUOROOCTANE SULFONIC ACID (CASRN 1763-23-1)

Health Effects Summary

Human health effects associated with chronic, low environmental exposures to perfluorooctane sulfonic acid (PFOS) are unknown. Perfluorooctane sulfonic acid is slowly eliminated and therefore accumulates in the human body. Its estimated human serum biological half-life (time necessary for half of dose to be eliminated) is 4.8-5.4 years. The biological half-life of perfluorooctane sulfonic acid in other species, including rats and monkeys, is much smaller (48-121 days).

Animals exposed to perfluorooctane sulfonic acid via ingestion exhibited decreased body weight, decreased cholesterol, decreased liver weight, increased liver fat, and liver histopathology. Animal reproductive and developmental studies showed decrease survival and weight of offspring. Animals exposed during gestation and lactation had higher serum glucose levels and their offspring exhibit insulin resistance as adults

Epidemiological studies of workers exposed to perfluorooctane sulfonic acid via inhalation and general populations exposed via drinking water report increased cholesterol and high density lipoproteins (HDLs), decreased female fertility and decreased weight of offspring.

Data used for Groundwater Standard

U.S. EPA's Office of Water established an oral reference dose (RfD) of 0.00002 mg/kg-day for perfluorooctane sulfonic acid based on decreased rat pup body weight in a two-generation reproductive study (https://www.epa.gov/sites/production/files/2016-05/documents/pfos_hesd_final_508.pdf_.
A systemic threshold concentration of 0.14 µg/L can be calculated using the oral reference dose for perfluorooctane sulfonic acid in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA considers perfluorooctane sulfonic acid as having "suggestive evidence of carcinogenic potential" according to its 2005 Guidelines for Carcinogen Risk Assessment. Liver tumors were reported at the highest dose tested in a long-term rat study. However, there is lack of demonstrated genotoxicity and comparable human epidemiological evidence from workers exposed to perfluorooctane sulfonic acid. The U.S. EPA Office of Water has not derived a cancer slope factor for perfluorooctane sulfonic because the weight of evidence for human carcinogenic is limited. A human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated per the requirements of 15A NCAC 02L .0202(d)(2).

No aqueous odor threshold, aqueous taste threshold, federal maximum contaminant level (MCL) or secondary drinking water standard has been established for perfluorooctanane sulfonic acid.

Recommended Groundwater Standard

U.S. EPA Office of Water issued a Health Advisory and Health Effects Support Document for Perfluorooctane Sulfonic Acid Acid (PFOS) in 2016. The Health Advisory of 0.07 µg/L was calculated based on reduced pup body weight using the 90th percentile drinking water intake and body weight of lactating women and represents the most recent evaluation published by the US EPA. Alternatively, the calculation provided by the derivation of the non-cancer endpoint (0.1 ug/L) is advised.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

Groundwater Standard Summary Document
Division of Water Resources

The recommended groundwater standard for perfluorooctane sulfonic acid (PFOS) is 0.07 ug/L (ppb) based on the calculated noncancer systemic threshold using the 90th percentile drinking water intake and body weight of lactating women.

Uses

Perfluorooctane sulfonic acid is used as a water and oil repellent and as a surfactant in firefighting foams. It is used in carpet, upholstery, and textiles in waterproofing and stain resistance applications. It is also used in food packaging as a paper grease proofing agent. It is commonly used as the sodium or potassium form of the acid.

References

Agency for Toxic Substances and Disease Control. 2015. Toxicological Profile for Perfluoroalkyls. U.S. Department of Health and Human Services. (https://www.atsdr.cdc.gov/toxprofiles/index.asp)

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

Luebker, D.J., M.T. Case, R.G. York, J.A. Moore, K.J. Hansen, and J.L. Butenhoff. 2005b. Two-generation reproduction and cross-foster studies of perfluorooctanesulfonate (PFOS) in rats. Toxicology 215:126–148.

Olsen GW, Burris JM, Ehresman DJ, Froehlich JW, Seacat AM, Butenhoff JL, Zobel LR. 2007. Half-life of serum elimination of perfluorooctanesulfonate, perfluorohexanesulfonate, and perfluorooctanoate in retired fluorochemical production workers. Environ Health Perspect. 115(9):1298-305.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA Guidelines for Carcinogen Risk Assessment. 2005. (EPA/630/P-03/001B). Risk Assessment Forum, Washington, DC. (https://www.epa.gov/risk/guidelines-carcinogen-risk-assessment).

U.S. EPA Drinking Water Health Advisory for Perfluorooctane Sulfonic Acid (PFOS). 2016. Office of Water. (EPA 822-R-16-004) https://www.epa.gov/sites/production/files/2016-05/documents/pfos_hesd_final_508.pdf

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

Groundwater Standard Summary Document
Division of Water Resources

PERFLUOROOCTANOIC ACID (PFOA) (CASRN 335-67-1)

Health Effects Summary

Human health effects associated with chronic, low environmental exposures to perfluorooctanoic acid (PFOA) are unknown. Perfluorooctanoic acid is slowly eliminated from humans and accumulates in the body. It has an estimated biological half-life (time necessary for half of dose to be eliminated) of 3.5-4 years.

Animals exposed to perfluorooctanoic acid via ingestion exhibited liver and kidney toxicity, immune effects, developmental effects and liver, testicular, and pancreatic cancer. Epidemiological studies of workers exposed to perfluorooctanoic acid via inhalation and general populations exposed via drinking water report high cholesterol, increased liver enzymes, decreased vaccination response, thyroid disorders, pregnancy induced hypertension and preeclampsia, and testicular and kidney cancer.

Data used for Groundwater Standard

U.S. EPA's Office of Water established an oral reference dose (RfD) of 0.00002 mg/kg-day for perfluorooctanoic acid based on skeletal variations and accelerated puberty observed in male mice offspring (https://www.epa.gov/sites/production/files/2016-05/documents/pfoa_hesd_final_508.pdf). A systemic threshold concentration of 0.14 µg/L can be calculated using the oral reference dose for perfluorooctanoic acid in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA considers perfluorooctanoic acid as having "suggestive evidence of carcinogenic potential" according to its 2005 Guidelines for Carcinogen Risk Assessment. U.S. EPA Office of Water derived a cancer slope factor of 0.07 $(mg/kg\text{-}day)^{-1}$ for perfluorooctanoic acid based on testicular cancer (Leydig cells) observed in rats. A human exposure concentration of 0.50 µg/L associated with an incremental lifetime cancer risk estimate of 1×10^{-6} can be calculated per the requirements of 15A NCAC 02L .0202(d)(2).

No aqueous odor threshold, aqueous taste threshold, federal maximum contaminant level (MCL) or secondary drinking water standard has been established for perfluorooctanoic acid.

Recommended Groundwater Standard

An interim maximum allowable concentration (IMAC) of 2 µg/L was established under 15A NCAC 02L .0202(c) for perfluorooctanoic acid in 2006. New toxicological information relevant to the derivation of a North Carolina groundwater standard is available. U.S. EPA Office of Water issued a Health Advisory and Health Effects Support Document for Perfluorooctanoic Acid (PFOA) in 2016. The Health Advisory of 0.07 µg/L was calculated based on potential adverse effects for fetuses during pregnancy and breastfed infants using the 90th percentile drinking water intake and body weight of lactating women. Alternatively, the calculation provided by the derivation of the non-cancer endpoint (0.1 µg/L) is advised.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for perfluorooctanoic acid (PFOA) is 0.07 ug/L (ppb) based on the calculated noncancer systemic threshold using calculation parameters specific to lactating women.

Groundwater Standard Summary Document
Division of Water Resources

Uses

Perfluorooctanoic acid is used as a water and oil repellent, a surfactant in firefighting foams, and as an intermediate in the synthesis of fluoroacrylic esters. It is used in Teflon, floor waxes and polishes, outdoor clothing and similar chemicals (known as fluorotelomers). According to the 2010/2015 EPA PFOA Stewardship Program, manufacture of PFOA was scheduled to be phased out by 2015.

References

Agency for Toxic Substances and Disease Control. 2015. Toxicological Profile for Perfluoroalkyls. U.S. Department of Health and Human Services. (https://www.atsdr.cdc.gov/toxprofiles/index.asp)

Amoore, JE and Hautala E. 1983. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatiles for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, Volume 3. No. 6.

Lau, C., J.R. Thibodeaux, R.G. Hanson, M.G. Narotsky, J.M. Rogers, A.B. Lindstrom, and M.J. Strynar. 2006. Effects of perfluorooctanoic acid exposure during pregnancy in the mouse. Toxicological Sciences 90:510–518.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA Guidelines for Carcinogen Risk Assessment. 2005. (EPA/630/P-03/001B). Risk Assessment Forum, Washington, DC. (https://www.epa.gov/risk/guidelines-carcinogen-risk-assessment).

U.S. EPA Health Effects Support Document for Perfluorooctanoic Acid (PFOA). 2016. Office of Water. (EPA 822-R-16-003)
https://www.epa.gov/sites/production/files/201605/documents/pfoa_health_advisory_final-plain.pdf

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

Total Perfluorooctane sulfonic acid (PFOS) and Perfluorooctanoic acid (PFOA)

CASRNs 1763-23-1 and 335-67-1

North Carolina Groundwater (GW) Standard = 0.07 µg/L*

Summary

The North Carolina GW standard for total perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202 (highlighted in yellow below).
Critical health effect: Reduced pup body weight, 2-generation rat gavage study (PFOS) and reduced ossification of the forelimbs and hindlimbs and accelerated puberty in male mice pups (PFOA).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

	PFOS	PFOA	
RfD = reference dose[1]	2.0E-05	2.0E-05	mg/kg/day
WT = average adult human body weight[2]	70	70	kg
RSC= relative source contribution[3]	0.2	0.2	unitless value
WI = average daily human adult water intake[4]	2	2	L/day
1000 = conversion factor	1000	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**0.1**	**0.1**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	1.0E-06	
WT = average adult human body weight[2]	70	70	kg
q1* = carcinogenic potency factor (slope factor)[5]	NA	0.07	$(mg/kg\ /day)^{-1}$
WI = average daily human adult water intake[4]	2	2	L/day
1000 = conversion factor	1000	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**0.5**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**NA**	**NA**	**µg/L**
Odor Threshold[7]	**NA**	**NA**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**NA**	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**NA**	**µg/L**

Additional Information

US EPA Health Advisory for PFOA/PFOS (2016)[10]	**0.07**	**0.07**	**µg/L**
Practical Quantitation Limit (PQL)[11]	0.002	0.002	µg/L

References

[1] US EPA Drinking Water Health Advisory for Perfluorooctane sulfonic acid (PFOS). 2016. US EPA Office of Water (EPA 822-R-16-004); US EPA Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA). 2016. US EPA Office of Water (EPA 822-R-16-005)

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] Average adult water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[5] US EPA has not classified PFOS for carcinogenicity. A cancer slope factor is not available; US EPA Office of Water derived a cancer slope factor for PFOA based on testicular cancer observed in rats. Human epidemiological studies evaluating the carcinogenicity of PFOA are equivocal for kidney and testicular cancer.US EPA Health Effects Support Document for Perfluorooctanoic Acid. 2016. US EPA Office of Water (EPA 822-R-16-003)

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[7] NA; Contact NC DEQ Groundwater Standards Coordinator for list of odor threshold resources examined.

[8] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic

[9] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.

[10] US EPA Office of Water derived the Health Advisory for PFOS using the 90th percentile consumers-only estimate of combined direct and indirect community water ingestion for lactating women (Table 3-81 in US EPA 2011 Exposure Factors Handbook). A value of 0.054 L/kg-day was used in the calculation which equates roughly to 3.8 L of water consumed per day for a 65 Kg woman. * EPA established equivalent Health Advisory Levels of 0.07 µg/L for PFOA and PFOS. The Health Advisory Level also applies to the sum total of both compounds if they co-occur.

[11] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. PQL from NC DEQ certified commercial laboratory.

NA = Not available

History

December 2016- IMAC for PFOS developed by DWR in conjunction with review for PFOA.

Groundwater Standard Summary Document
Division of Water Resources

PROPYLENE GLYCOL (CASRN 57-55-6)

Health Effects Summary
Human health effects associated with oral exposures to propylene glycol are unknown.

Sub-chronic and chronic drinking water and dietary animal studies have shown hematological effects following exposure to propylene glycol (U.S. EPA, 2008).

Available chronic oral toxicity studies suggest that propylene glycol is not carcinogenic in rats and dogs. Based on numerous studies and available evidence, there is no indication that propylene glycol is genotoxic (U.S. EPA, 2008).

Data used for Groundwater Standard
U.S. EPA's Integrated Risk Information System (IRIS) has not established an oral reference dose (RfD) for propylene glycol.

U.S. EPA has derived a Provisional Peer-Reviewed Toxicity Value (PPRTV) for propylene glycol. PPRTVs are developed using similar methods, data sources, and Agency guidance that are used by the IRIS program in order to derive toxicity values from relevant scientific literature. A provisional oral reference dose (p-RfD) of 17 mg/kg-day (rounded to 20 mg/kg-day) was derived based on a 5-week drinking water study in rats (Vaille et al., 1971). The study identified a LOAEL of 5200 mg/kg for reduced red blood cell count and hyperglycemia and an uncertainty factor of 300 was applied (10 for variation in sensitivity among the human population, 10 for interspecies extrapolation, and 3 for estimating a NOAEL from a LOAEL). A systemic threshold concentration of 119,000 µg/L (ppb) can be calculated using the p-RfD of 17 mg/kg-day for propylene glycol in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA has not evaluated propylene glycol for carcinogenicity. A cancer potency factor is not available. Therefore, a human exposure concentration associated with an incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated according to the requirements of 15A NCAC 02L .0202(d)(2).

An odor threshold of 340,000 µg/L has been reported for propylene glycol (Alexander et al., 1982).

No taste threshold has been reported and no federal maximum contaminant level or secondary drinking water standard has been established for propylene glycol.

Recommended Groundwater Standard
An interim maximum allowable concentration (IMAC) of 140,000 µg/L was established under 15A NCAC 02L .0202(c) for propylene glycol in 2012, based on the rounded p-RfD of 20 mg/kg-day. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

A groundwater standard of 100,000 µg/L (rounded from 119,000 µg/L) for propylene glycol is being recommended at this time.

Groundwater Standard Summary Document
Division of Water Resources

Use

Propylene glycol has been classified by the Food and Drug Administration (FDA) as generally recognized as safe (GRAS) for use as a food additive (FDA, 1982). It is a clear, colorless liquid substance that is added to food and cosmetic products in order to absorb and maintain moisture. Propylene glycol is also used as a base for deicing solutions and to make polyester compounds. Additional applications include use as an antifreeze in chemical and pharmaceutical industries, and as a solvent in paint and plastic industries (ATSDR, 1997).

References

Alexander H.C., McCarty W.M., Bartlett E.A. and Syverud A.N. (1982). Aqueous odor and taste threshold values of industrial chemicals. *American Water Works Association*, 74(11), 595-599.

ATSDR (Agency for Toxic Substances and Disease Registry). (1997). Toxicological Profile for Ethylene Glycol and Propylene Glycol. PB/98/101108/AS.

FDA (Food and Drug Administration). 1982. GRAS status of propylene glycol and propylene glycol monostearate. Federal Register. June 25. 47: 27810-27813.

U.S. EPA. (1991). Integrated Risk Information System (IRIS) Chemical Assessment Summary for Propylene Glycol. National Center for Environmental Assessment, Office of Research and Development. https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0543_summary.pdf#nameddest=rfd

U.S. EPA. (2008). Provisional Peer Reviewed Toxicity Values (PPRTV) for Propylene Glycol. Superfund Health Risk Technical Support Center, National Center for Environmental Assessment, Office of Research and Development (EPA 690-R-08-019F). https://cfpub.epa.gov/ncea/pprtv/documents/PropyleneGlycol.pdf

U.S. EPA. (2018). Drinking Water Standards and Health Advisories. Office of Water (EPA 822-F-18-001). https://www.epa.gov/sites/production/files/2018-03/documents/dwtable2018.pdf

U.S. National Library of Science Toxicology Data Network (TOXNET)

Vaille C., Debray C., Roze C. et al. (1971). (Hyperglycemic action of propylene glycol.) *Ann. Pharm. Fr.* 29, 577-582. (French) (Cited in WHO, 1974)

North Carolina Groundwater Standard

Propylene glycol CASRN 57-55-6

North Carolina Groundwater (GW) Standard = 100000 µg/L

Summary

The North Carolina GW standard for propylene glycol is based on a noncancer endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202. Groundwater standards are established as the least of the criteria in 15A NCAC 02L .0202(d)(1-6) (highlighted in yellow below).
Critical health effect: reduced red blood cell counts and hyperglycemia in rats (rats exposed to 5.2 g/kg-day for 5 weeks)

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	17	mg/kg/day	
WT = average adult human body weight[2]	70	kg	
RSC= relative source contribution	0.2	unitless value	
WI = average daily human adult water intake[3]	2	L/day	
1000 = conversion factor	1000	µg/mg	
Calculated GW Standard using noncancer endpoint	**119000**	**µg/L**	**(rounded to 100,000 to account for significant figures)**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.0E-06	
WT = average adult human body weight[2]	70	kg
q1* = carcinogenic potency factor (slope factor)[4]	NA	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[3]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[5]	**NA**	**µg/L**
Odor Threshold[6]	**3.40E+05**	**µg/L**
Maximum Contaminant Level (MCL)[7]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[8]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[9]

10,000 µg/L

References

[1] US EPA Provisional Peer Reviewed Toxicity Values for Propylene Glycol, accessed 7/16/2018; PPRTV assessment last revised 3/24/2008; Link to document: https://cfpub.epa.gov/ncea/pprtv/documents/PropyleneGlycol.pdf

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] NA; Propylene glycol has not been classified by US EPA for carcinogenicity for oral exposures. A cancer potency factor has not been established.

[5] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[6] Alexander H.C., McCarty W.M., Bartlett E.A. and Syverud A.N. (1982). Aqueous odor and taste threshold values of industrial chemicals. American Water Works Association, 74(11), 595-599.

[7] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed date).

[8] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.

[9] PQL provided for informational purposes only. PQL not established by North Carolina Water Resources Laboratory. PQL from NC DEQ certified commercial laboratory.

NA = Not available
RSC = 0.1 for nonorganics, 0.2 for organics

History

July 16, 2012- IMAC Effective Date

Groundwater Standard Summary Document
Division of Water Resources

2,4,5-TRICHLOROPHENOL (CASRN 95-95-4)

Health Effects Summary

Human health effects associated with low environmental exposures to 2,4,5-trichlorophenol are unknown. 2,4,5-Trichlorophenol, a gray, flaky solid, is an eye, skin, and mucous membrane irritant. It is categorized as a chlorophenol and may be contaminated with trace amounts of dibenzo-p-dioxins.

There are limited toxicological data available for oral exposures to 2,4,5-trichlorophenol. Increased kidney weights were reported in rats following 18 days of gavage doses of 2,4,5-trichlorophenol. Slight degenerative kidney and liver changes were reported in a 98-day rat feeding study with 2,4,5-trichlorophenol. Increased maternal mortality and decreased maternal weight gain were reported in rats exposed to 2,4,5-trichlorophenol during days 6-15 of gestation; no adverse effects were reported in offspring.

Data used for Groundwater Standard

U.S. EPA's Integrated Risk Information System (IRIS) established an oral reference dose (RfD) of 0.1 mg/kg-day for 2,4,5-trichlorophenol based on slight degenerative kidney and liver changes observed in a 98-day rat feeding study (http://www.epa.gov/iris/). A systemic threshold concentration of 700 µg/L (ppb) can be calculated using the oral reference dose for 2,4,5-trichlorophenol in accordance with 15A NCAC 02L .0202(d)(1).

U.S. EPA classified 2,4,5-trichlorophenol as Category D for carcinogenicity (not classifiable for human carcinogenicity. A cancer potency factor is not available. An incremental lifetime cancer risk estimate of 1×10^{-6} cannot be calculated using this data per the requirements of 15A NCAC 02L .0202(d)(2).

An aqueous taste threshold of 100 µg/L and an aqueous odor threshold of 63 µg/L has been reported for 2,4,5-trichlorophenol (Young et al., 1996). No federal drinking water maximum contaminant level (MCL) or secondary drinking water standard has been established.

Recommended Groundwater Standard

An interim maximum allowable concentration (IMAC) of 63 µg/L was established under 15A NCAC 02L .0202(c) for 2,4,5-trichlorophenol in 2010. No new toxicological information relevant to the derivation of a North Carolina groundwater standard is available.

Groundwater standards are to be the "lesser of" the criteria in 15A NCAC 02L .0202(d)(1-6).

The recommended groundwater standard for 2,4,5-trichlorophenol is 63 µg/L (ppb) based on the aqueous odor threshold.

Uses

2,4,5-Trichlorophenol has been used as a fungicide, bactericide, and biocide. It is used as an intermediate in the production of the herbicides, 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T). It is used as a preservative in polyvinyl acetate emulsions, rayon industry emulsions, and in rubber gaskets for the automotive industry. Cooling towers, paper and pulp mill systems, hide and leather processing, and food processing plants also use 2,4,5-trichlorophenol.

Groundwater Standard Summary Document
Division of Water Resources

References

Agency for Toxic Substances and Disease Registry. Toxicological Profile for Chlorophenols. 1999. US Department of Health and Human Services http://www.atsdr.cdc.gov/

Chernoff N, Setzer RW, Miller DB, et al. 1990. Effects of chemically induced maternal toxicity on prenatal development in the rat. Teratology 42:65l-658.

McCollister, D.D., D.T. Lockwood and V.K. Rowe. 1961. Toxicologic information on 2,4,5-trichlorophenol. Toxicol. Appl. Pharmacol. 3: 63-70.

U.S. EPA Drinking Water Standards and Health Advisories. 2018. Office of Water. https://www.epa.gov/sdwa/2018-drinking-water-standards-and-advisory-tables

U.S. EPA Integrated Risk Information System. 1987. IRIS Chemical Summary for 2,4,5-Trichlorophenol. http://www.epa.gov/iris (accessed December 20, 2016).

U.S. National Library of Science Toxicology Data Network (TOXNET) https://toxnet.nlm.nih.gov/

Young WF, Horth H, Crane R, Ogden T and Arnott M. 1996. Taste and odour threshold concentrations of potential potable water contaminants. Water Research, 30:2, pp. 331-340.

North Carolina Groundwater Standard Calculation Sheet

2,4,5-Trichlorophenol CASRN 95-95-4

North Carolina Groundwater (GW) Standard = 63 µg/L

Summary The North Carolina GW standard for 2,4,5-trichlorophenol is based on an aqueous odor endpoint in accordance with selection criteria defined in 15A NCAC 02L .0202. Groundwater standards are established as the least of the criteria in 15A NCAC 02L .0202(d)(1-6) (highlighted in yellow below). Critical health effect: Aqueous odor threshold (non-health based).

GW standard based on noncancer endpoint

GWQS = [(RfD x WT x RSC) / WI] * 1000

RfD = reference dose[1]	1.00E-01	mg/kg/day
WT = average adult human body weight[2]	70	kg
RSC= relative source contribution[3]	0.2	unitless value
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using noncancer endpoint	**700**	**µg/L**

GW Standard based on cancer endpoint

GWQS = [(RL x WT) / (q1* x WI)] * 1000

RL = risk level	1.00E-06	
WT = average adult human body weight[2]	NA	kg
q1* = carcinogenic potency factor (slope factor)[5]	N/A	(mg/kg /day) $^{-1}$
WI = average daily human adult water intake[4]	2	L/day
1000 = conversion factor	1000	µg/mg
Calculated GW Standard using cancer endpoint	**NA**	**µg/L**

GW Standards based on published values

Taste Threshold[6]	**100**	**µg/L**
Odor Threshold[7]	**63**	**µg/L**
Maximum Contaminant Level (MCL)[8]	**NA**	**µg/L**
Secondary Drinking Water Standard (SMCL)[9]	**NA**	**µg/L**

Practical Quantitation Limit (PQL)[10]

10 µg/L

References

[1] Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/ accessed 12/20/16). IRIS assessment last revised 1/31/1987. McCollister, D.D., D.T. Lockwood and V.K. Rowe. 1961. Toxicologic information on 2,4,5-trichlorophenol. Toxicol. Appl. Pharmacol. 3: 63-70.

[2] Average adult body weight from 15A NCAC 02L .0202 (effective date April 1, 2013).

[3] RSC=0.1 for nonorganics, 0.2 for organics in accordance with 15A NCAC 02L .0202 (effective date April 1, 2013).

[4] Average water consumption from 15A NCAC 02L .0202 (effective date April 1, 2013).

[5] NA; 2,4,5-Trichlorophenol is classified as Category D for carcinogenicity (not classificable as to human carcinogenicity). A cancer potency factor is not available.

[6] NA; Contact NC DEQ Groundwater Standards Coordinator for list of taste threshold resources examined.

[7] Young WF, Horth H, Crane R, Ogden T and Arnottt M. 1996. pp. 331-340.

[8] NA; MCL: https://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants#Organic (accessed 12/20/16)

[9] NA; SMCL : https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals

[10] PQL provided for informational purposes only. PQL established by North Carolina Water Resources Laboratory for 2,4,5-trichlorophenol under semivolatile organics (https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/organic-chemistry-branch/methods-pqls-organics)

NA = Not available

History

April 27, 2010 - Division of Waste Management (DWM) requested IMAC for 2,4,5-trichlorophenol.=
October 1, 2010 - IMAC of 63 µg/L approved by DWR Director.

Proposed Groundwater Standards in North Carolina and Summary Groundwater Regulations in Surrounding States

Pollutant	CAS Registry Number	North Carolina Proposed GW Standard (µg/L)	South Carolina (µg/L)	Virginia (µg/L)	Tennessee (µg/L)
Acetic acid	64-19-7	5,000			
Acetochlor	34256-82-1	100			
Acetochlor ESA	187022-11-3	500			
Acetochlor OXA	184992-44-4	500			
Acetophenone	98-86-2	700		1900	
Acrolein	107-02-8	4		0.042	
Alachlor	15972-60-8	2	2		2
Aldrin	309-00-2	0.002		0.00092	
Antimony	7440-36-0	1	6	6	6
Benzyl Alcohol	100-51-6	700		2000	
Beryllium	7440-41-7	4	4	4	4
Bromomethane	74-83-9	10		7.5	
Butanol-n	71-36-3	590			
Butanol-sec	78-92-2	10,000			
4-Chlorotoluene	106-43-4	24			
Cobalt	7440-48-4	1		6	
Dalapon	75-99-0	200	200		200
DDE	72-55-9	0.1		0.046	
1,4-Dibromobenzene	106-37-6	70			
Dichloroacetic acid	79-43-6	0.7			
2,4-Dichlorophenol	120-83-2	0.98		46	
2,4-Dinitrotoluene	121-14-2	0.05		0.24	
2,6-Dinitrotoluene	606-20-2	0.05		0.049	
Dinoseb	88-85-7	7		7	7
Diphenyl ether	101-84-8	180			
Diquat	85-00-7	20	20		20
Endosulfan sulfate	1031-07-8	40		NA	
Endothall	145-73-3	100	100		100
alpha-Hexachlorocyclohexane	319-84-6	0.006		0.0072	
beta-Hexachlorocyclohexane	319-85-7	0.02		0.025	
4-Isopropyltoluene	99-87-6	25			
Methyl butyl ketone	591-78-6	40		38	
Methyl isobutyl ketone	108-10-1	100		6300	
Methyl methacrylate	80-62-6	25		1400	
1-Methylnapthalene	90-12-0	1			
2-Methylphenol	95-48-7	400		930	
Perfluorooctane sulfonic acid (PFOS) and Perfluorooctanoic acid (PFOA), total	1763-23-1; 335-67-1	0.07			
Propylene glycol	57-55-6	100,000			
Strontium	7440-24-6	2,000			
1,2,4,5-Tetrachlorobenzene	95-94-3	2		1.7	
1,1,1,2-Tetrachloroethane	630-20-6	1		0.57	
Thallium	7440-28-0	2	2	2	2
Tin (inorganic forms)	7440-31-5	2,000		12000 (total)	
1,1,2-Trichloroethane	79-00-5	0.6	5	5	5
2,4,5-Trichlorophenol	95-95-4	63		1200	
2,4,6-Trichlorophenol	88-06-2	3		4.1	
Vanadium	7440-62-2	7		86	

Proposed Groundwater Standards in North Carolina and Summary Groundwater Regulations in Surrounding States

Additional Information/Summary of Applicable State Regulations:

Tennessee: TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
CHAPTER 0400-40-03: GENERAL WATER QUALITY CRITERIA
(https://publications.tnsosfiles.com/rules/0400/0400-40/0400-40-03.20150406.pdf)
Rule 0400-40-03-.08 CRITERIA.
The water quality criteria for the different classes are as follows:
(2) General Use Ground Water
Except for naturally occurring levels, General Use Ground Water:
(a) shall not contain constituents that exceed those levels specified in subparagraphs (1)(j) and (k) of Rule 0400-40-03-.03; and
(b) shall contain no other constituents at levels and conditions which pose an unreasonable risk to the public health or the environment.

South Carolina: SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
R.61-68, WATER CLASSIFICATIONS & STANDARDS
(https://live-sc-dhec.pantheonsite.io/sites/default/files/media/document/R.61-68.pdf)
H. CLASS DESCRIPTIONS AND SPECIFIC STANDARDS FOR GROUND WATERS.
Class GB: All ground waters of the State, unless classified otherwise, which meet the definition of underground sources of drinking water (USDW) as defined in Section B.
Quality Standards for Class GB Ground Waters: Maximum contaminated levels as set forth in R.61-58, State Primary Drinking Water Regulations.
(https://www.scdhec.gov/sites/default/files/media/document/R.61-58.pdf)

Virginia: VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY
9VAC20-81-250. GROUNDWATER MONITORING PROGRAM
(https://law.lis.virginia.gov/admincode/title9/agency20/chapter81/section250/)
A groundwater monitoring program, per 9VAC20-81-250.A.6.a., requires that a ground water protection standard (GPS) be established for all detected Table 3.1 constituents. The GPS can be based on (9VAC20-81-250.6.b):
(1) maximum contaminant level (MCL) when available;
(2) site-specific background concentration, if this background is greater than MCL;
(3) site-specific background concentration for constituents for which MCLs have not been promulgated;
(4) risk-based alternate concentration levels for constituents for which MCLs have not been promulgated.
Alternate concentration levels (ACLs) can be found:
(https://www.deq.virginia.gov/programs/landprotectionrevitalization/solidhazardouswasteregulatoryprograms/solidwaste/groundwatermonitoring.aspx)

Historical Information on Requested Interim Maximum Allowable Concentrations (IMACs)

Pollutant	CAS Registry Number	Date Established	Requested by	Date Requested
Acetic acid	64-19-7	April 4, 2018	Hercules Incorporated	May 29, 2014
Acetochlor	34256-82-1	December 1, 2010	Monsanto	May 18, 2010
Acetochlor ESA	187022-11-3	December 1, 2010	Monsanto	May 18, 2010
Acetochlor OXA	184992-44-4	December 1, 2010	Monsanto	May 18, 2010
Acetophenone	98-86-2	April 1, 2011	NC DEQ Division of Waste Management	November 8, 2010
Acrolein	107-02-8	October 1, 2010	NC DEQ Division of Waste Management	April 27, 2010
Alachlor	15972-60-8	August 1, 2010	NC DEQ Division of Waste Management	February 10, 2010
Aldrin	309-00-2	October 1, 2010	NC DEQ Division of Waste Management	April 27, 2010
Antimony	7440-36-0	August 1, 2010	NC DEQ Division of Waste Management	February 10, 2010
Benzyl Alcohol	100-51-6	October 1, 2010	NC DEQ Division of Waste Management	April 27, 2010
Beryllium	7440-41-7	October 1, 2010	NC DEQ Division of Waste Management	April 27, 2010
Bromomethane	74-83-9	August 1, 2010	NC DEQ Division of Waste Management	February 10, 2010
Butanol-n	71-36-3	August 1, 2010	NC DEQ Division of Waste Management	February 10, 2010
Butanol-sec	78-92-2	October 1, 2010	NC DEQ Division of Waste Management	April 27, 2010
4-Chlorotoluene	106-43-4	October 1, 2010	NC DEQ Division of Waste Management	April 27, 2010
Cobalt	7440-48-4	October 1, 2010	NC DEQ Division of Waste Management	April 27, 2010
Dalapon	75-99-0	August 1, 2010	NC DEQ Division of Waste Management	February 10, 2010
DDE	72-55-9	August 1, 2010	NC DEQ Division of Waste Management	February 10, 2010
1,4-Dibromobenzene	106-37-6	August 1, 2010	NC DEQ Division of Waste Management	February 10, 2010
Dichloroacetic acid	79-43-6	October 1, 2010	NC DEQ Division of Waste Management	April 27, 2010
2,4-Dichlorophenol	120-83-2	August 1, 2010	NC DEQ Division of Waste Management	February 10, 2010
2,4-Dinitrotoluene	121-14-2	April 1, 2011	NC DEQ Division of Waste Management	November 8, 2010
Dinoseb	88-85-7	August 1, 2010	NC DEQ Division of Waste Management	February 10, 2010
Diphenyl ether	101-84-8	April 1, 2011	NC DEQ Division of Waste Management	November 8, 2010
Diquat	85-00-7	August 1, 2010	NC DEQ Division of Waste Management	February 10, 2010
Endosulfan sulfate	1031-07-8	April 1, 2011	NC DEQ Division of Waste Management	November 8, 2010
Endothall	145-73-3	August 1, 2010	NC DEQ Division of Waste Management	February 10, 2010
alpha-Hexachlorocyclohexane	319-84-6	April 1, 2011	NC DEQ Division of Waste Management	November 8, 2010
beta-Hexachlorocyclohexane	319-85-7	April 1, 2011	NC DEQ Division of Waste Management	November 8, 2010
4-Isopropyltoluene	99-87-6	April 1, 2011	Brewster Environmental, PLLC/Paramount Chevrolet; NC DEQ Division of Waste Management	November 8, 2010
Methyl butyl ketone	591-78-6	April 1, 2011	NC DEQ Division of Waste Management	November 8, 2010
Methyl isobutyl ketone	108-10-1	December 1, 2010	NC DEQ Division of Waste Management	June 4, 2010
Methyl methacrylate	80-62-6	August 1, 2010	NC DEQ Division of Waste Management	February 10, 2010
1-Methylnapthalene	90-12-0	April 1, 2011	NC DEQ Division of Waste Management	November 8, 2010
2-Methylphenol	95-48-7	April 1, 2011	NC DEQ Division of Waste Management	November 8, 2010
Perfluorooctane sulfonic acid (PFOS) and Perfluorooctanoic acid (PFOA), total	PFOS: 1763-23-1 PFOA: 335-67-1	PFOS: N/A PFOA: December 6, 2006	PFOS: N/A PFOA: NC DEQ Division of Waste Management/Public interest groups	PFOS: N/A PFOA: 2002-2003
Propylene glycol	57-55-6	July 16, 2012	Duncklee and Dunham/FLS Energy, Inc.	May 21, 2012
1,2,4,5-Tetrachlorobenzene	95-94-3	August 1, 2010	NC DEQ Division of Waste Management	February 10, 2010
1,1,1,2-Tetrachloroethane	630-20-6	August 1, 2010	NC DEQ Division of Waste Management	February 10, 2010
Thallium	7440-28-0	October 1, 2010	NC DEQ Division of Waste Management	April 27, 2010
Tin (inorganic forms)	7440-31-5	October 1, 2010	NC DEQ Division of Waste Management	April 27, 2010
1,1,2-Trichloroethane	79-00-5	August 1, 2010	NC DEQ Division of Waste Management	February 10, 2010
2,4,5-Trichlorophenol	95-95-4	October 1, 2010	NC DEQ Division of Waste Management	April 27, 2010
2,4,6-Trichlorophenol	88-06-2	October 1, 2010	NC DEQ Division of Waste Management	April 27, 2010
Vanadium	7440-62-2	October 1, 2010	NC DEQ Division of Waste Management	June 4, 2010

Additional Information: Available Cover Letters for IMAC Requests

North Carolina Department of Environment and Natural Resources
Division of Waste Management
Dexter R. Matthews
Director

Beverly Eaves Perdue
Governor

Dee Freeman
Secretary

February 10, 2010

Ms. Sandra Moore
State Water Quality Standards Co-coordinator
Division of Water Quality
NC Department of Environment and Natural Resources
1617 Mail Service Center, Raleigh, NC 27699-1617

Re: Interim Maximum Allowable Standard Proposal
Division of Waste Management

Dear Ms. Moore,

As per the discussion and agreement during the October 2009 meeting between the Division of Water Quality and the Division of Waste Management, the Division of Waste Management is proposing interim standards for the Division of Water Quality review and approval. The first batch of proposed interim standards is for 17 chemicals. We are going to add approximately 28 more chemicals in the near future. The proposed standards have not been rounded. The chemicals and proposed interim standards are:

Chemical	**CAS#**	**Proposed Interim Standard ug/l**
Alachlor	15972-60-8	2
Ammonia	7664-41-7	1,500
Antimony	7440-36-0	1.4
Bromomethane	74-83-9	9.8
Butanol	71-36-3	700
Chromium III	16065-83-01	100
Dalapon	75-99-0	200
1,4-Dibromobenzene	106-37-6	70
2,4-Dichlorophenol	120-83-2	0.98
p,p-Dichlorodiphenyldichloroethylene (DDE)	72-55-9	0.1029
Dinoseb	85-85-7	7
Diquat	85-00-7	15.40
Endothall	145-73-3	100
Methyl Methacrylate	80-62-6	25

1,2,4,5-Tetrachloroethane	95-94-3	2.10
1,1,1,2-Tetrachloroethane	630-20-6	1.3462
1,1,2-Trichloroethane	79-00-5	0.6140

If you have any questions please call me at (919) 508 8445.

Sincerely,

Hanna Assefa
Industrial Hygiene Consultant
Division of Waste Management

North Carolina Department of Environment and Natural Resources
Division of Waste Management

Beverly Eaves Perdue
Governor

Dexter R. Matthews
Director

Dee Freeman
Secretary

April 27, 2010

Ms. Sandra Moore
State Water Quality Standards Co-coordinator
Division of Water Quality
NC Department of Environment and Natural Resources
1617 Mail Service Center, Raleigh, NC 27699-1617

Re: Interim Maximum Allowable Concentration Proposal
Division of Waste Management

Dear Ms. Moore,

The Division of Waste Management is submitting the second batch of interim maximum allowable groundwater concentration (IMAC) proposals for Division of Water Quality review and approval. There are 18 chemicals in this batch. The proposed IMACs have not been rounded.

Chemical	**CAS#**	**Proposed Interim Standard ug/l**
Acrolein	107-02-8	3.5
Aldrin	309-00-2	0.0021
Benzyl Alcohol	100-51-6	700
Beryllium	7440-41-7	4
Butyl Alcohol sec	78-92-2	14,000
p-Chlorotoluene	106-43-4	24
Cobalt	7440-48-4	1.05
Dibromomethane (methylene bromide)	74-95-3	70
Dichloroacetic Acid	79-43-6	0.7
1,2-Dichloroethylene mixed isomers	540-59-0	63
Methyl Isobutyl Ketone	108-10-1	560
Perchlorate and Perchlorate Salts	7790-98-9	4.90
Picramic Acid	96-91-3	0.70
Thallium	7440-28-0	0.23
Tin	7440-31-5	2100
2,4,5-Trichlorophenol	95-95-4	700
2,4,6-Trichlorophenol	88-06-2	3.5
Vanadium	7440-62-2	0.3
Vinyl Acetate	108-05-4	88

If you have any questions please call me at (919) 508 8445.

Sincerely,

Hanna Assefa
Industrial Hygiene Consultant
Division of Waste Management

1646 Mail Service Center, Raleigh, North Carolina 27699-1646
Phone: 919-508-8400 \ FAX: 919-715-4061 \ Internet: www.wastenotnc.org

MONSANTO

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18 May 2010

Coleen Sullins, Director
Division of Water Quality,
NC Department of Environment and Natural Resources
1617 Mail Service Center
Raleigh, NC 27699-1617

Subject: **Request for IMACs for Acetochlor, Acetochlor ESA and Acetochlor OXA**

Dear Ms. Sullins:

Last year, during a meeting with Sandra Moore, other Division of Water Quality staff, and Henry Wade and Bob Bruss from the Department of Agriculture and Consumer Services, we discussed recently approved uses for acetochlor on cotton and soybean. As part of those discussions, the benefit of having North Carolina issue IMACs for acetochlor and its main environmental degradates was highlighted.

In response to those discussions, we are herewith submitting a formal request to have IMACs established for acetochlor, acetochlor ethane sulfonic acid (acetochlor ESA), and acetochlor oxanilic acid (acetochlor OXA). To aid your Division in undertaking the process of establishing IMACs, and the approval of the IMACs by the NC Environmental Management Commission (EMC), we have attached a draft document for your consideration and potential use in calculating and supporting IMACs for these chemicals.

Should your team have any technical questions concerning these materials, please follow-up directly with our toxicologist, Dr. James Sherman, at 314-694-9053.

Sincerely,

David I Gustafson, Ph.D.
Senior Fellow & Registration Manager

enclosures

cc: Sandra Moore, NC DWQ
Bob Bruss, NC DACS
Henry Wade, NC DACS
Jim Sherman, Monsanto
Jim Baxter, Dow AgroSciences

North Carolina Department of Environment and Natural Resources
Division of Waste Management

Beverly Eaves Perdue
Governor

Dexter R. Matthews
Director

Dee Freeman
Secretary

MEMORANDUM

Date: November 8, 2010

To: Coleen Sullins, Director
Division of Water Quality

From: Dexter R. Mathews, Director
Division of Waste Management

RE: Establishment of New Interim Maximum Allowable Concentrations (IMACs)

The Division of Waste Management (DWM) has submitted to the Division of Water Quality (DWQ) proposed interim maximum allowable concentrations (IMACs) for 16 chemicals. DWM is also currently waiting for the USEPA to establish toxicological values for tetrahydorfuran. We expect the assessment of tetrahydrofuran to be complete in December. Tetrahydrofuran is present in soil and groundwater at some of our contaminated sites and therefore we will be submitting a request for an IMAC at that time. After that, requests will be made as needed.

The chemicals include chlorinated and non-chlorinated solvents, agricultural chemicals such as pesticides and herbicides. The Different programs within DWM are involved in the assessment and remediation of releases of these chemicals in groundwater. Therefore, groundwater standards are needed for target cleanup levels. The inventory of sites under DWM regulatory oversight are chemical and furniture industry sites, abandoned chemicals and waste of various types, agricultural chemical releases, landfills, metalworking, wood treating, printing, plating and military facilities and underground storage tank releases among many other type of releases. Similarly, we encounter the pesticides, herbicides, intermediates and solvent carriers at sites where agricultural chemicals have been stored, disposed or spilt during mixing. In regards to agricultural chemicals, DWM only has authority to require remediation where the contamination is not due to normal application. However, we understand DWQ and the Department of Agriculture may want to be aware of cases of contamination due to normal application of pesticides for protection of water quality purposes and restriction of pesticide use.

We hope this explains our need for developing IMACs for a more expanded list of chemicals than presently exists. A list of the proposed IMACs is included at the end of this memorandum. Please let us know if we can assist further in the development of IMACs for these chemicals. Please call me at (919) 508 8414 if you have any questions.

1646 Mail Service Center, Raleigh, North Carolina 27699-1646
Phone: 919-508-8400 \ FAX: 919-715-4061 \ Internet: www.wastenotnc.org

Chemical	CAS#	Proposed Interim Standard ug/l
Acetophenone	98-86-2	700
Benzaldehyde	100-52-7	700
Carbazole	000086-74-8	1.8
Diphenyl Ether	101-84-8	105
2,4-Dinitrotoluene	121-14-2	14
Endosulfan Sulfate	115-29-7	42
Ethanol	64-17-5	3,500
Ethyl tert Butyl Ether	63-79-23	47
Hexachlorocyclohexane, alpha	319-84-6	5.56E-03
Hexachlorocyclohexane, beta	319-85-7	1.94E-2
2-Hexanone	591-78-6	35
4-Isopropyl Toluene	99-87-6	25
1-Methyl Napthalene	90-12-0	1.2
2-Methyl Phenol	95-48-7	350
tert-Amyl Methyl Ether	994-05-8	128
Tert-Butyl Alcohol	75-65-0	12

November 8, 2010

Ms. Coleen H. Sullins
State Water Quality Standards
Division of Water Quality Planning Section
NC Department of Environment and Natural Resources
1617 Mail Service Center
Raleigh, NC 27699-1617

Re: Request for the Development of an
Interim Maximum Allowable Concentration (IMAC)
p-Isopropyltoluene (4-Isopropyltoluene)

Paramount Chevrolet (Site)
3309 Highway 70 Bypass East
(604 Corporate Drive)
Goldsboro, Wayne County, North Carolina
Groundwater Incident #18342

Dear Ms. Sullins**,**

Please consider this a formal request for the development of an Interim Maximum Allowable Concentration (IMAC) for isopropyltoluene. I have provided this brief summary of the available information and logic for proposing an IMAC for p-isoproyltoluene.

p-Isopropyltoluene

p-Isopropyltoluene is an important product and valuable intermediate in the chemical industry. Among others, it is used as a solvent for dyes and varnishes, as a heat transfer medium, as an additive in fragrances and musk perfumes, and as a masking odor for industrial products. Review of published studies shows a calculated RfD of 0.1 mg/kg-day. This chemical has been determined to have a low toxicity.

This request is directed specifically towards the currently unlisted constituent 4-isopropyltoluene. This constituent is also known as p-isopropyltoluene, methylisopropylbenzene, p-cymene. Isomers of cymene include the ortho, meta and para configurations.

Review of available literature for this compound shows that cymene (isopropyl toluene) is not current identified as a carcinogen by ACGIH, IARC, NTP or California Proposition 65. The Merck index lists the LD50 of the para isomer of cymene (p-isopropyltoluene) at 4,750 mg/kg (rat).

Based on the current 2L standards set for other substituted benzenes, and the published LD50 for cymene (isopropyl toluene at 4,750 mg/kg) we respectfully request that an interim standard for this compound be determined/proposed as an Interim Maximum Allowable Concentration under 15A NCAC 2L.

As an organic constituent, isopropyltoluene is similar in structure to other substituted benzenes, which there are current standards under 15A NCAC 2L. Specifically:

- xylene (LD50 - 5000 mg/kg), current 2L standard set at 530 ug/l,
- trimethyl benzene (LD50 – 7230 mg/kg), current 2L standard set at 350 ug/l,
- toluene (LD50 – 636 mg/kg), current 2L standard set at 1,000 ug/l,
- n-propyl benzene (LD50 – 6,040 mg/kg), current 2L standard set at 70 ug/l, and
- isopropyl benzene (LD50 – 1,400 mg/kg), current 2L standard set at 70 ug/l.

Considering the compound is currently not listed as a known carcinogen and the relatively high published LD50 of 4,750 mg/kg we propose an interim standard to be set at the lowest of the above referenced groundwater standards referenced for other like substituted benzene compounds (n-propyl benzene and iso-propyl benzene) at 70 ug/l.

This Interim Maximum Allowable Concentration (IMAC) is being requested in reference to the pending closure of an open groundwater incident at an old groundwater site (1998) that was shifted into the Inactive Sites Branch. The source was removed in 1998 and current groundwater monitoring shows a source concentration for p-isopropyltoluene at 0.63 ppb.

IMAC REQUEST – PROPOSED STANDARD

In accordance with 15A NCAC 2L 0.202 we have calculated a proposed Interim Maximum Allowable Concentration (IMAC) for 4-isopropyltoluene. The State of North Carolina currently does not have a published standard for this compound. In addition there is not a current published reference dose (RfD) for this particular compound.

We propose that a reference dose be established by reference to a structurally similar compound and to use a compound that has been utilized by others to develop a groundwater standard for p-isopropyltoluene. This approach has been utilized for other organic compounds that do not have published reference doses (RfDs).

In correspondence with personnel with the State of Maine, Center of Disease Control (CDC) has determined Maximum Exposure Guidelines (MEGs). Ms. Diane Silverman indicated that they had used the approach of comparing isopropyltoluene to a structural surrogate cumene (1-methylethylbenzene, LD 50 – 2,910 mg/kg), which has a pulished RfD of 0.1 mg/kg. The structural surrogate approach was chosen as the compound in question, is not a listed carcinogen. A safety factor of 10X was employed to arrive at an estimated RfD for isopropyltoluene of 0.01 mg/kg. According to personnel at the State of Maine, the MEG we have for

Be 115 ½ E. Hargett Street Suite 240 Raleigh, NC 27601 Tel: (919) 889-3241

isopropyltoluene is based on the RfD for isopropylbenzene (cumene; 0.1 mg/kg-day) adjusted by the application of a ten-fold uncertainty factor for the use of a structural surrogate. Therefore, the RfD used for in the MEG calculation is 0.01mg/kg-day. The approach has not been changed since no compound-specific information is available for this compound.

Following the prescribed formula we arrive at an estimated groundwater standard of 70 ug/mg:

RfD 0.01 mg/kg/day X 70kg body weight (adult) X Relative Source Contribution 0.2 (organics) / 2 liters water/day (average consumption) = 70 ug/l (Proposed IMAC for p-isopropyltoluene)

The compound does not appear to be a known carcinogen, nor is there a listed odor threshold. The compound does not appear on any other list to provide a published RfD.

We appreciate you time and assistance in the consideration of this request for a proposed IMAC for p-isopropyltoluene.

If you have any questions concerning this request, please do not hesitate to contact me at (919) 889-3241.

Respectfully,

David C. Brewster, LG
Brewster Environmental, PLLC

cc: Ms. Sandra Moore
Dr. Ken Rudo
Doug Guild
Jan Chenowith, Young Realty
Paul Benton, CCOG
File

Be 115 ½ E. Hargett Street Suite 240 Raleigh, NC 27601 Tel: (919) 889-3241

5/23 Ted → Mark → Dianne

C-167

DUNCKLEE & DUNHAM

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511 KEISLER DRIVE – SUITE 102
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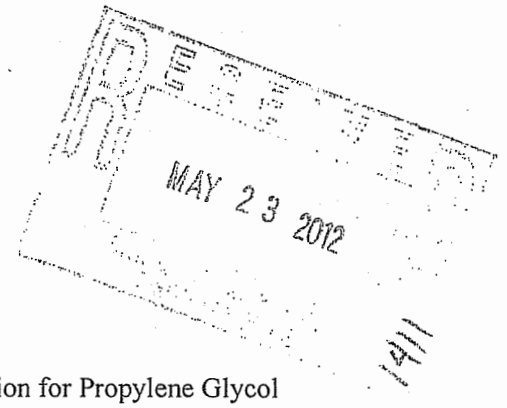
WWW.DUNCKLEEDUNHAM.COM

VIA EMAIL TO: chuck.wakild@ncdenr.gov

May 21, 2012



Mr. Chuck Wakild
North Carolina Department of Environment and Natural Resources
Division of Water Quality
1601 Mail Service Center
Raleigh, North Carolina 27699-1601

Reference: Request for Interim Maximum Allowable Concentration for Propylene Glycol
FLS Energy
St. Pauls, North Carolina

Dear Mr. Wakild:

On behalf of our client, FLS Energy, Inc. (FLS), Duncklee & Dunham, P.C. (Duncklee & Dunham) respectfully submits this formal request to have an Interim Maximum Allowable Concentration (IMAC) of 140 mg/L established for propylene glycol (CAS# 57-55-6) through the Division of Water Quality and Environmental Management Commission rule-making process. There have been several releases of propylene glycol from FLS' solar panel installation located at 4470 Highway 20 East in St. Pauls, North Carolina. FLS uses the solar array panels to generate electricity.

The risk-based residential and industrial preliminary soil remediation goal (PSRG) for direct contact have been calculated by the Division of Waste Management's Inactive Hazardous Sites Branch (IHSB), and are both set at the maximum ceiling concentration of 100,000 mg/kg, which indicates the low toxicity associated with this compound. The availability of these PSRGs demonstrated to us that toxicological data was available for this compound. However, there is no protection of groundwater PSRG currently available and a 15A NCAC 15A 2L groundwater quality standard has never been calculated for this compound. The miscibility of the compound and its low toxicity, it is expected the protection of groundwater PSRG will be the most stringent PSRG and will also be the level to which our client will need to remediate the soil.

If FLS Energy can demonstrate concentrations in soil are below the protection-of-groundwater PSRG and the groundwater concentrations are below the IMAC before August 1, 2012, then they will not need to enter the IHSB's registered environmental consultant (REC) voluntary remediation program. This compound is not deemed toxic and breaks down quickly in the environment. The REC program requirements are more applicable to remediation of hazardous substances that are long lasting in the environment. Therefore, there is a great financial incentive for FLS to meet the IMAC and protection-of-groundwater PSRG in the next few months. The remediation results will be provide the same level of

protection to the environment as would be obtained through the REC Program once the IMAC and soil-to-groundwater PSRG are available.

We have attached support information related to propylene glycol, including our calculated IMAC. We would very much appreciate an expedited review of our calculations, due to the work that must be completed prior to August 1, 2012. If FLS cannot demonstrate closure goals have been met by that time, they will have to enter the REC program to close out the site, and the costs associated with a remedial effort under the REC program is far more expensive while providing no additional protection to the environment. Additionally, the financial incentive to meet this upcoming deadline will result in the expedient remediation of the propylene glycol.

If you or members of your staff have any questions concerning the attached materials or other background information, please feel free to contact Daphne Jones at (919) 858-9898 or via email to daphne@dunckleedunham.com

Sincerely,

Duncklee & Dunham, P.C.

Daphne M. Jones, P.G., R.S.M.
Senior Geologist

Senior Peer Review:

Thomas S. Dunham, P.G.
Senior Geologist

Attachments: Support Information for Propylene Glycol
Proposed IMAC, Propylene Glycol

ec: Sandra Moore, NC DWQ, sandra.moore@ncdenr.gov
Chris Dunbar, FLS Energy, cdunbar@flsenergy.com

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HERCULES

Hercules Incorporated
Hercules Research Center
500 Hercules Road
Wilmington, DE 19808-1599
Writer's Direct Dial: 302-995-3456

May 29, 2014

Ms. Connie Brower
North Carolina Department of Environment and Natural Resources
Water Quality, Planning Section
512 N. Salisbury Street
Raleigh, North Carolina 27604

Re: Technical Memorandum - Calculations for IMACs for Acetic Acid and P-Toluic Acid
Former Cape Industries Facility
Wilmington, North Carolina

Dear Ms. Brower:

Hercules Incorporated (Hercules) is pleased to provide this Technical Memorandum (prepared by Dr. Bruce Fishman of RBR Consulting, Inc.) for the calculation of Interim Maximum Allowable Concentrations (IMACs) for two constituents, acetic acid and p-toluic acid. The calculations have been developed in accordance with 15A NCAC 02L .0202.

Two (2) hard copies have been provided in this submittal.

Hercules appreciates the opportunity to work with NCDENR on this project and looks forward to receiving feedback from the agency on this initial submittal. Once finalized, the formal IMAC petition request will be submitted to the Director of the Division of Water Resources for review and consideration.

Should you have any questions regarding this submittal, please contact me at (302) 995-3456.

Respectfully submitted,

Timothy D. Hassett, P.E.
Project Manager

EH&S & PR

TDH/
Hercules IMAC memo

Attachments: Technical Memorandum - Calculations for IMACs for Acetic Acid and P-Toluic Acid

cc: J. Keller – GES, Inc.
E. Wright – GES, Inc.
B. Fishman – RBR, Inc.
T. Slusser – NCDENR
D. Watts – NCDENR
G. Kreiser - NCDENR
N. Marsh - EPA
E. Meyer – INVISTA
S. Simpson – Celanese