Fact Sheet Date: 9/27/2017

NEW YORK STATE
- AQUATIC FACT SHEET -

Ambient Water Quality Value
For Protection of Aquatic Life

SUBSTANCE: 1,4-Dioxane **CAS REGISTRY NUMBER:** 123-91-1

TYPE:	**BASIS:**	**Ambient Water Quality Value, µg/L** FRESHWATER	**SALTWATER**
Chronic	Propagation	18,000 µg/L	7,000 ug/L
Acute	Survival	160,000 µg/L	63,000 ug/L

INTRODUCTION

These values apply to the water column and are derived to protect aquatic life from the effects of waterborne contaminants. Values for the protection of propagation of aquatic life are referred to as Aquatic (Chronic) *or* A(C) values. Values for the protection of survival of aquatic life are referred to as Aquatic (Acute) *or* A(A) values. The procedures for deriving Tier I and Tier II acute and chronic values for the protection of aquatic life in both fresh and salt water are described in 6NYCRR Part 706.1.

CHEMICAL BACKGROUND

1,4-Dioxane has a chemical formula of $C_4H_8O_2$ and a molecular weight of 88.10. It is a colorless liquid, or solid below 53°F, with a faint pleasant, mild, ether-like odor. Its density is 1.0329 @ 20°C. It is miscible in water and has a log K_{ow} of -0.27. 1,4-Dioxane is used as a solvent for cellulose compounds, natural and synthetic resins, fats, oils, waxes, and spirit-soluble dyes; as a degreasing agent; and as a stabilizer in chlorinated solvents. It is also used as a solvent in pulping of wood and as a wetting and dispersing agent in textile processing. It is an ingredient in cleaning and detergent preparations, adhesives, cosmetics, deodorants, fumigants, emulsions and polishing compositions (HSDB 2006). In 1985 in the USA about 90% of the 1,4-dioxane produced served as a stabilizer for chlorinated solvents, particularly 1,1,1-trichloroethane. The remaining 10% was used in the solvent area (EU 2002).

If released into water, hydrolysis and photolysis in sunlit surface waters is not expected to be an important environmental fate process for 1,4-dioxane, since this compound lacks functional groups that hydrolyze or absorb light under environmentally relevant conditions. Because of its low K_{ow}, 1,4-dioxane is not expected to adsorb to suspended solids and sediment, and volatilization from water surfaces is the primary fate process. The volatilization half-lives for a model river and model lake are 5 and 56 days, respectively. After it volatilizes from water, it is expected to exist in the atmosphere solely as a vapor, and be degraded by reaction with photochemically-produced hydroxyl radicals with a half-life in air of about 35 hours. 1,4-Dioxane has been found to be resistant to biodegradation in water (HSDB 2006).

SUMMARY OF INFORMATION AND DERIVATION OF VALUES

The sources of aquatic toxicity data for 1,4-dioxane were the EPA's ECOTOX aquatic toxicity database, the Hazardous Substance Data Bank (HSDB 2006), and a European Community Risk Assessment (EU 2002). Because of its use as a stabilizer in other chlorinated solvents, it is not unusual to detect it when other chlorinated solvents are found, such as resulting from spills, so it is a chemical of interest. 1,4-Dioxane exhibits generally low toxicity to aquatic organisms, with LC_{50}s in the grams per liter range. Probably as a result of its low acute aquatic toxicity, aquatic toxicity data are limited and the existing studies are older studies that evaluated the aquatic toxicity of large numbers of industrial chemicals. For 1,4-dioxane, Tier II acute and chronic values were derived for the protection of aquatic life in both freshwater and saltwater.

DERIVATION OF ACUTE VALUES

A Tier I aquatic life value is a value derived using acute toxicity data from all eight minimum data requirements (MDRs) listed in 6NYCRR Part 706.1(III). A Tier II aquatic life value is derived when less than eight MDRs are satisfied.

The procedure to derive a Tier II water quality value is as follows: the lowest genus mean acute value (GMAV) of all acceptable studies is first identified. Then, the Secondary Acute Value (SAV) is calculated by dividing the lowest GMAV by a secondary acute factor (SAF), which is based on the number of MDRs satisfied (see Table 1 of 6NYCRR Part 706.1(XII)). Lastly, the Tier II acute value (A(A)) for the protection of aquatic life is calculated by dividing the SAV by two.

6NYCRR Part 706.1(XII) does not provide SAF values for saltwater. The saltwater SAF values needed to derive a Tier II value were obtained from (Host, et al. 1995) as allowed under 702.9(g)(1).

Freshwater

The freshwater acute toxicity data used to derive the 1,4-dioxane acute value for freshwater are listed in Table 1. In order to calculate a SAV, the toxicity data available must contain, as a minimum, a GMAV for a cladoceran in the Family Daphnidae (6 NYCRR Part 706.1(XII)). The preferred test for a cladoceran is a test with a duration of 48 hours (6 NYCRR Part 706.1(IV)(E)(1)). The available toxicity data for 1,4-dioxane contained several studies for genera in the Family Daphnidae; however, the tests were only 24 hours in duration. Specifically, Bringmann and Kuhn (1977) reported a *Daphnia magna* 24 hour static EC_{50} for immobilization of 4,700,000 μg/L. This was not the lowest test result in the database, so it would not drive the derivation of the SAV. A 48 hour test would be expected to produce a lower EC_{50} than a 24 hour test, however, despite that possibility, a decision was made to use the results of the 24 hour *Daphnia magna* EC_{50} for the following reasons:

- Without using it, a SAV and water quality values could not be derived;
- The *Daphnia magna* EC_{50} was not the lowest, i.e., most sensitive value. The lowest LC_{50} was for the amphipod *Gammarus pseudolimnaeus*, which is also an aquatic invertebrate;
- The *Daphnia magna* EC_{50} is just slightly more than 2 times larger than the amphipod LC_{50}. Although it would most likely be lower, it seems unlikely that the *Daphnia magna* EC_{50} would be cut in half had the test been run for 48 hours instead of 24.

Therefore, it seems unlikely that even if a 48 hour EC_{50} for *Daphnia magna* were available, it would be significantly lower than the 96 hour LC_{50} for *Gammarus pseudolimnaeus*; so the *Gammarus* GMAV would remain the lowest GMAV available in the 1,4-dioxane data set and used to derive the SAV for 1,4-dioxane.

The lowest GMAV of 2,274,000 µg/L was used to derive a Tier II water quality value for 1,4-dioxane. With four MDRs satisfied, a secondary acute factor (SAF) of 7.0 was used to derive a secondary acute value (SAV): 2,274,000 µg/L ÷ 7.0 = 324,857.14 µg/L. To derive the Tier II freshwater acute aquatic life value (A(A)), the SAV was divided by two and rounded to two significant digits: 324,857.14 ÷ 2 = 162,428.57 ≈ 160,000 µg/L.

<u>Saltwater</u>

The saltwater acute toxicity data used to derive the 1,4-dioxane acute value for saltwater are listed in Table 2. The lowest GMAV of 6,700,000 µg/L was used to derive the Tier II value. With only 1 MDR satisfied, and data for a species from the Genus Menidia available but data from the either the Family Mysidae or Penaeidae absent, a secondary acute factor (SAF) of 52.8 was used to derive a secondary acute value (SAV): 6,700,000 µg/L ÷ 52.8 = 126,893.94 µg/L. The SAF values for saltwater are not included in 6 NYCRR Part 706.1. Saltwater SAF values were obtained from Host, et al (1995) instead. To derive the Tier II freshwater acute aquatic life value (A(A)), the SAV was divided by two and rounded to two significant digits: 126,893.94 ÷ 2 = 63,446.97 ≈ 63,000 µg/L.

DERIVATION OF CHRONIC VALUES

A Tier I Final Chronic Value (FCV) is derived either using chronic toxicity data for all eight MDRs listed in 6NYCRR Part 706.1(III) or by using measured acute to chronic ratios (ACRs) for at least three species. A Tier II Secondary Chronic Value (SCV) is derived when less than three measured ACRs are available. An ACR is the ratio between the EC_{50}/LC_{50} from an acute test and the endpoint from a chronic test, which is usually the Maximum Acceptable Toxicant Concentration (MATC). The MATC is geometric mean of the NOEC (No Observed Effects Concentration) and the LOEC (Lowest Observed Effects Concentration)[1].

[1] Synonymous terms are the no observed effects level (NOEL) and lowest observed effects level (LOEL).

If three or more ACRs are available for the chemical, a Final ACR (FACR) is determined by calculating their geometric mean. The Tier I FCV is determined by dividing the Tier I FAV by the FACR. If fewer than three ACRs are available for the chemical, a Secondary ACR (SACR) is determined by using enough assumed ACRs of 18 so that the total number of ACRs equals three. The SACR is then calculated as the geometric mean of the measured and assumed ACRs. If no measured ACRs are available, the SACR is 18. The Tier II SCV is determined by dividing either the Tier I FAV or the Tier II SAV by the SACR. The Tier II chronic value (A(C)) is the lower of the SCV or the Final Plant Value (FPV).

Freshwater

No acceptable chronic freshwater toxicity data were available for 1,4-dioxane. EU (2002) reported a NOEC of 625,000 µg/L for 1,4-dioxane in a seven day static renewal test with *Ceriodaphnia dubia*, however this value could not be used to derive an acute to chronic ratio because no acceptable corresponding acute study had been conducted. Because no acceptable chronic toxicity data were available, an assumed SACR of 18 was used. To calculate the freshwater SCV, the freshwater SAV is divided by the SACR: 324,857.14 µg/L ÷ 18 = 18,047.62 ≈ 18,000 µg/L.

Saltwater

No acceptable chronic saltwater toxicity data were available for 1,4-dioxane. Because no acceptable chronic toxicity data were available, an assumed SACR of 18 was used. To calculate the saltwater SCV, the freshwater SAV is divided by the SACR: 126,893.94 µg/L ÷ 18 = 7,049.66 ≈ 7,000 µg/L.

Final Plant Value

The Final Plant Value (FPV) is the lowest plant value that was obtained with an important aquatic plant species in an acceptable toxicity test. Bringmann and Kuhn (1978) reported a LOEC for algae (freshwater diatom), *Scenedesmus quadricauda* exposed to 1,4-dioxane, of 5,600,000 µg/L.

Selection of the A(C) Value

The A(C) value is the lowest of either the FPV or the SCV. The freshwater SCV is lower than the freshwater diatom FPV, and there was no FPV for saltwater. The freshwater and saltwater SCVs were rounded to two significant digits and used as the Tier II chronic aquatic life values. The A(C) value for freshwater = 18,047.62 ≈ 18,000 µg/L; and 7,049.66 ≈ 7,000 µg/L for saltwater.

Table 1. Freshwater toxicity data used to derive the 1,4-dioxane acute value. Data categories are listed in order they appear in 6NYCRR 706.1(III)(B)(1)(a-h) NDA - No Data Available

Data Requirement	**Species (Common name - Family)**	**Endpoint Conc. µg/L**	**SMAV µg/L**	**GMAV µg/L**	**Rank**	**Reference**
Family Salmonidae	NDA					
A second family in the Class Osteichthyes	*Pimephales promelas* (fathead minnow – Cyprinidae)	9,850,000 9,872,000 10,800,000	10,164,555	10,164,555	4	Geiger, et al. 1990 Brooke L. 1987 Geiger, et al. 1990
A third family from the phylum Chordata	*Lepomis macrochirus* (bluegill sunfish – Centrarchidae)	4,269,000	4,269,000	4,269,000	2	Brooke, L. 1987
A planktonic crustacean	*Daphnia magna* (waterflea – Daphniidae)	4,700,000	4,700,000	4,700,000	3	Bringmann and Kuhn, 1977
A benthic crustacean	*Gammarus pseudolimnaeus* (amphipod – Gammaridae)	2,274,000	2,274,000	2,274,000	1	Brooke, L. 1987
An insect	NDA					
A family in a phylum other than Arthropoda or Chordata	NDA					
A family in any order of insect or any other phylum not already represented	NDA					

Table 2. Saltwater toxicity data used to derive the 1,4-dioxane acute value. Data categories are listed in order they appear in 6NYCRR 706.1(III)(C)(1)(a-e) NDA - No Data Available

Data Requirement	**Species (Common name-Family)**	**Endpoint Conc. µg/L**	**SMAV µg/L**	**GMAV µg/L**	**Rank**	**Reference**
A family from the phylum Chordata	Menidia beryllina (Inland silverside – Atherinidae)	6,700,000	6,700,000	6,700,000	1	Dawson, et al. 1977
A second family from the phylum Chordata	NDA					
A family in a phylum other than Arthropoda or Chordata	NDA					
Either the Mysidae or Penaeidae family	NDA					
A family not in the family Chordata; may include Mysidae or Penaeidae, which ever was not used above	NDA					
A family not in the family Chordata; may include Mysidae or Penaeidae, which ever was not used above	NDA					
A family not in the family Chordata; may include Mysidae or Penaeidae, which ever was not used above	NDA					
Any other family	NDA					

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