

GROUNDWATER INFORMATION SHEET

1,4 Dioxane

The purpose of this groundwater information sheet is to provide general information regarding a specific constituent of concern (COC). The information provided herein relates to groundwater sources used for public drinking water, not water served at the tap.

GENERAL INFORMATION	
Constituent of Concern	1,4 Dioxane
Synonyms	1,4 Diethylene dioxide, 1,4 Dioxacyclohexane, <i>p</i> -dioxane, Glycol ethylene ether, Diethylene ether, Dioxane
Chemical Formula	C ₄ H ₈ O ₂
CAS No.	123-91-1
Storet No.	A-032
Summary	<p>The State Water Resources Control Board (SWRCB) has adopted a drinking water notification level (NL) of 1 microgram per liter (µg/L). 1,4 Dioxane is primarily used as stabilizer and solvent. It is also a component of some cosmetics, detergents, and shampoos. The US Environmental Protection Agency (US EPA) classifies 1,4 Dioxane as a possible human carcinogen. 1,4 Dioxane is highly soluble in water. Exposure pathways include ingestion of drinking water, inhalation of vapors, and workplace contact. Maximum contaminant levels (MCLs) have not been established for 1,4 Dioxane.</p> <p>Based on SWRCB data from 2007 to 2017, 191 active and standby public water supply wells (of 1,320 wells sampled) had at least one detection of 1,4 Dioxane above the NL. Most wells with detections occurred in Los Angeles (161) and Orange (28) counties. There was also one detection above the NL in Monterey and Santa Barbara counties.</p>

REGULATORY WATER QUALITY LEVELS¹		
1, 4 DIOXANE		
State and Federal MCLs have not been established for this constituent.		
Type	Agency	Concentration
Health Advisory Level, based on 1 in 10 ⁻⁶ cancer risk	US EPA ²	0.35 µg/L
State NL ³	SWRCB ⁴	1 µg/L
Public Health Protective Concentration	OEHHA ⁵	3 µg/L
Source Removal (Response Level)	SWRCB ⁴	35 µg/L

¹These levels are generally related to drinking water. Other water quality levels may exist. For further information, see "A Compilation of Water Quality Goals", 17th Edition (SWRCB 2016).

² US EPA – United States Environmental Protection Agency

³ The NL is only for the ingestion of drinking water, and does not take in to consideration possible dermal or inhalation exposures resulting from typical household uses of water containing a specific constituent of concern. Prior to 2004, NLs were referred to as "Action Levels" in California.

⁴ SWRCB - State Water Resources Control Board

⁵ OEHHA – Office of Environmental Health Hazard assessment

1,4 DIOXANE DETECTIONS IN PUBLIC WATER WELL SOURCES⁶	
Number of active and standby public water wells with 1,4 Dioxane ⁷ concentrations >1 µg/L.	191 of 1,320 wells sampled.
Top counties with active and standby public water wells with 1,4 Dioxane concentrations >1 µg/L.	Los Angeles (161), Orange (28), Monterey (1), Santa Barbara (1)

⁶ Water from public active and standby public groundwater sources is typically treated to prevent exposure to chemical concentrations above MCLs. Data from private domestic wells and wells with less than 15 service connections are not available.

⁷ Based on 2007-2017 public standby and active well (groundwater sources) data collected by the SWRCB.

ANALYTICAL INFORMATION		
Method	Detection Limit	Note
EPA 522	0.020-0.036 µg/L	Drinking water
Modified EPA 8260	0.5-10.0 µg/L	Groundwater, hazwaste
Known Limitations to Analytical Methods	Measurement of 1,4 Dioxane at the micrograms per liter level (µg/L) can be difficult due to its high solubility in water.	
Public Drinking Water Testing Requirements	Testing is required, although an MCL has not been established for this constituent. Notification is recommended by SWRCB if concentrations above 1 µg/L are observed.	

1,4 DIOXANE OCCURRENCE	
Anthropogenic Sources	1,4 Dioxane is primarily used as a stabilizer for chlorinated solvents. It is also used as a solvent for a number of compounds including resins, oils, fats, waxes, and greases. 1,4 Dioxane is also found as a byproduct in cosmetics and shampoos. 1,4 Dioxane is widely manufactured and distributed in the United States. Its occurrence as a byproduct in cosmetics is decreasing due to revised methodologies.
Natural Sources	1,4 Dioxane is a manufactured chemical that does not occur naturally in the environment.
History of Occurrence	The compound has been manufactured since the 1950s. As of 2001, 22 different domestic suppliers have been identified for 1,4 Dioxane. Production of the chemical has fallen significantly from the nearly 15 million pounds produced in 1982, possibly because most uses of trichloroethane, to which it was added as a stabilizer, have been banned in this country. According to the Toxic Release Inventory for 2014, 96,437 pounds of 1,4 Dioxane were released to the air, 24,262 to surface water, none to land, and 422,943 pounds were transferred from the facility for off-site disposal. The occurrence of 1,4 Dioxane in the environment is thought to be related to the disposal of chemical solvents containing dioxane and from disposal of 1,4 Dioxane itself. Subsequent leaching of the chemicals from landfills has resulted in contamination of groundwater.
Contaminant Transport Characteristics	1,4 Dioxane is a volatile, flammable, colorless liquid at room temperature. It is miscible with water and highly mobile in soils, where it can rapidly migrate to groundwater. 1,4 Dioxane has been observed above notification levels in groundwater and public groundwater sources in California.

REMEDATION & TREATMENT TECHNOLOGIES

Some types of chemical treatment are highly effective in removing 1,4 Dioxane from water. Advanced oxidation processes, which use peroxide and Ultraviolet light (UV) or ozone, have been shown to destroy 1,4 Dioxane. Chlorination has also been found to be effective for the removal of 1,4 Dioxane. However, the byproducts that result from chlorination of 1,4 Dioxane are significantly more toxic than 1,4 Dioxane itself. Standard wastewater treatment methods and conventional activated sludge methods have proven to be ineffective. Air-stripping and granular activated charcoal do not remove 1,4 Dioxane from water.

Experimental remediation techniques include the use of specialized bacteria in bioreactors under specific conditions and phytoremediation, where trees are used to draw shallow groundwater towards the surface as well as remove the constituent of concern.

HEALTH EFFECT INFORMATION

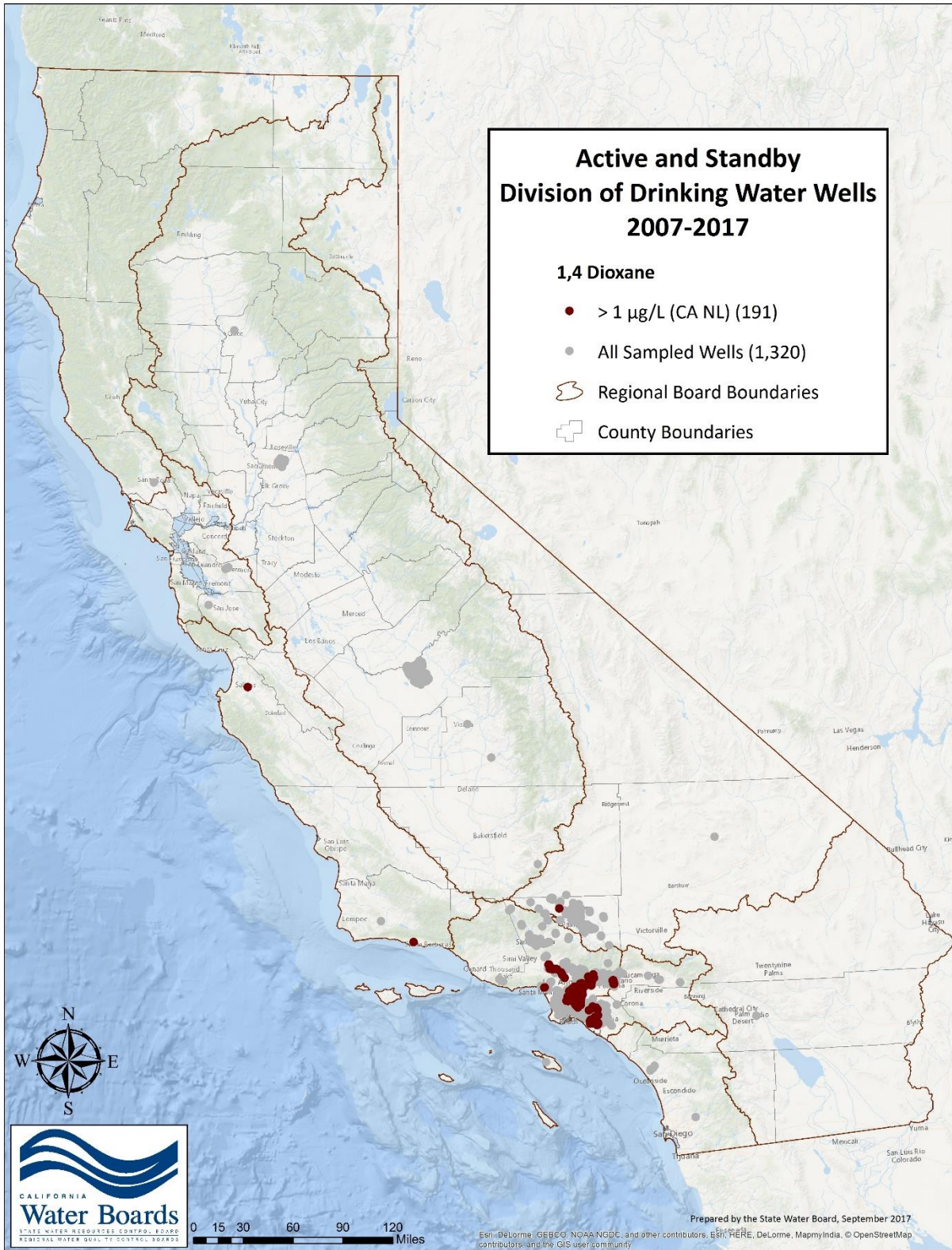
The primary exposure pathways for 1,4 Dioxane are through inhalation, ingestion, and dermal exposure. Inhalation of vapors can occur through occupational contact and through contact with water containing 1,4 Dioxane. Ingestion can occur through drinking contaminated water. Dermal exposure can occur at manufacturing facilities and through use of household products including cosmetics and shampoos. While trace amounts of 1,4 Dioxane are found in some cosmetics and shampoos, the levels observed in these products are generally very low.

Few studies are available that provide information about 1,4 Dioxane in humans. Deaths have been reported from accidental exposures to high amounts of vapors and skin absorption. Studies with workers exposed to lower levels of 1,4 Dioxane for longer time periods did not show significant harmful health effects. Controlled exposure of volunteers to the airborne contaminant for periods ranging from a few minutes to 6 hours produced eye, nose, and throat irritation.

Information was not available regarding reproductive, developmental, or immunological effects of 1,4 Dioxane in humans. However, available data is sufficient to clearly identify the liver and kidney as the target organs for 1,4 Dioxane toxicity following short-term exposure to relatively high concentrations regardless of the route of exposure. These findings have been corroborated in animal studies.

KEY REFERENCES

1. Agency for Toxic Substances and Disease Registry. 2012. U.S. Department of Health and Human Services. Division of Toxicology and Environmental Medicine ToxFQAQs, 1,4-Dioxane. <http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=954&tid=199>
2. California Department of Public Health. 2012. Drinking Water Notification Levels http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/notificationlevels/notificationlevels.pdf
3. National Toxicology Program. Department of Health and Human Services, 2014. 14th Report on Carcinogens. <http://ntp.niehs.nih.gov/ntp/roc/content/profiles/dioxane.pdf>
4. State Water Resources Control Board. A Compilation of Water Quality Goals, 17th Edition, (SWRCB, 2016). http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/docs/wq_goals_text.pdf
5. Mohr, T.K.G., 2001. Solvent Stabilizers, Santa Clara Valley Water District, White Paper
6. United States Environmental Protection Agency. 2014. Technical Fact Sheet. 1,4-dioxane. https://www.epa.gov/sites/production/files/2014-03/documents/ffrro_factsheet_contaminant_14-dioxane_january2014_final.pdf
7. United States Environmental Protection Agency. 2012 Edition of the Drinking Water Standards and Health Advisories. <https://www.epa.gov/sites/production/files/2015-09/documents/dwstandards2012.pdf>
8. US EPA Technology Innovation and Field Services Division, Contaminated Site Clean-Up Information, 1,4 Dioxane, <https://clu-in.org/contaminantfocus/default.focus/sec/1,4-Dioxane/cat/Overview/>
9. Zenker, M.J., Borden R.C., and Morton B., 2003. Occurrence and Treatment of 1,4 Dioxane in Aqueous Environments. Environmental Engineering Science, v.20 pg:423-432
10. US EPA TRI Explorer. Release Chemical Report database. https://iaspub.epa.gov/triexplorer/tri_release.chemical



Active and standby public drinking water wells that had at least one detection of 1,4 Dioxane above the NL, 2007-2017, 191 wells. (Source: Public Well Data in GeoTracker GAMA).