

Appendix D  
Toxic Pollutant Profiles

Analysis of Toxic Pollutant Sources and Characteristics Contributing to  
Water Quality Impairments in the Willamette River Basin

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# Toxic Pollutant Profile | 1,1-Dichloroethene (DCE)

<p>Profile</p>	<p>Classification: Volatile Organic Compound (VOC)</p> <p>CASRN: 75-35-4</p> <p>Molecular Formula: C<sub>2</sub>H<sub>2</sub>Cl<sub>2</sub></p> <p>IUPAC Name: 1,1,-Dichloroethene</p> <p>Synonyms: 1,1-dichloroethylene, Vinyl Chloride, Vinylidene Chloride</p> <p>Source: (EPA, 2017)</p> <div> </div> <p>Description</p> <p>1,1-DCE is a clear, colorless liquid that is a man-made chemical and is not found naturally in the environment. This chemical is used to make other chemicals/products.</p> <p>Chemical Characteristics</p> <table border="1"> <tbody> <tr> <td>Molecular Weight (g/mol)</td><td>97</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>1.22 @ 25°C</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>2,500 @ 25°C</td></tr> <tr> <td>Boiling Point (°C)</td><td>32</td></tr> <tr> <td>Melting Point (°C)</td><td>-123</td></tr> <tr> <td>Octanol-water partition coefficient (log K<sub>ow</sub>)</td><td>2.13</td></tr> <tr> <td>Octanol-air partition coefficient (log K<sub>oa</sub>)</td><td>2.60</td></tr> <tr> <td>Organic carbon-water distribution coefficient (log K<sub>oc</sub>)</td><td>1.81</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td>600 @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td>0.19 @ 25°C</td></tr> </tbody> </table> <p>Source: (ATSDR, 1994; EPA, 2012; SRC, 2013)</p> <p>Organic Solvents</p> <p>Soluble in organic solvents.</p> <p>Source: (ATSDR, 1994)</p>	Molecular Weight (g/mol)	97	Density (g/cm <sup>3</sup> )	1.22 @ 25°C	Water Solubility (mg/L)	2,500 @ 25°C	Boiling Point (°C)	32	Melting Point (°C)	-123	Octanol-water partition coefficient (log K <sub>ow</sub> )	2.13	Octanol-air partition coefficient (log K <sub>oa</sub> )	2.60	Organic carbon-water distribution coefficient (log K <sub>oc</sub> )	1.81	Vapor Pressure (mmHg)	600 @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	0.19 @ 25°C
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<p>Sources</p>	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>Breakdown of polyvinylidene chloride products (in landfills)</li> </ul> <p>Non-natural Sources/Uses:</p> <ul style="list-style-type: none"> <li>Manufacturing/processing (produced by dehydrochlorination of 1,1,2-trichloroethane with lime/caustic)</li> <li>Production of polyvinylidene chloride polymers (i.e., flexible packing materials [food], flame retardant coatings for fiber/carpet backing, steel pipe coatings, and adhesives)</li> </ul> <p>Releases to Air</p> <p>Emissions of 1,1-DCE to the atmosphere are reported from manufacturing/processing (polymer production/fabrication), storage/handling/transportation, stripping contaminated groundwater, hazardous waste sites, and landfills.</p>																				

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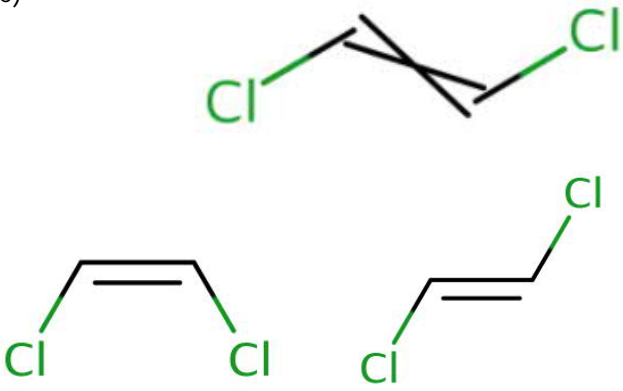
	<p>Releases to Soil Releases of 1,1-DCE to soil are reported from manufacturing/processing and municipal landfills (i.e., consumer products leaching).</p> <p>Releases to Water Releases of 1,1-DCE to surface waters and groundwater are reported from industrial releases (spills/leaks/effluent discharges) including manufacturing/processing facilities, metal finishing/nonferrous metals manufacturing industries, soap/detergent manufacturers, electric coil coating/battery manufacturers, coal mines, laundries, paint/ink formulation industries, municipal wastewater treatment facilities, hazardous waste sites, and abiotic elimination or dehydrochlorination transformations.</p> <p>Source: (ATSDR, 1994)</p>									
Transport and Fate	<p>Transformation &amp; Degradation 1,2-DCE is a degradation product of trichloroethene (TCE) (a degradation product of tetrachloroethene [PCE]), which degrades into vinyl chloride, and eventually to ethane.</p> <ul style="list-style-type: none"><li>• In air, 1,1-DCE can degrade in the atmosphere via gas-phase oxidation with photochemically produced hydroxyl radicals and direct photolytic degradation. It will likely not be removed by wet atmospheric deposition.</li><li>• In water (ground), 1,1-DCE biotransforms predominantly under anaerobic conditions. Photolysis, hydrolysis, and oxidation in aquatic media are not significant processes.</li><li>• In sediment and soil, degradation of 1,1-DCE via methane-utilizing culture is possible.</li></ul> <p>Partitioning</p> <ul style="list-style-type: none"><li>• In air 1,1-DCE is very volatile and will ultimately partition into the atmosphere.</li><li>• In water, 1,1-DCE is not found in high concentrations in surface water.</li><li>• In soil, if percolation from water or surface soil occurs, it will partition between soil and water; it will migrate freely through soil and within groundwater.</li></ul> <p>Bioaccumulation/Bioconcentration Bioconcentration in plants, aquatic organisms, and animals is not expected to be significant. Bioaccumulation in the food chain is not expected to be significant.</p> <p>Sources: (ATSDR, 1994, 2014; EPA, 2017)</p>									
Water Quality Regulations	<p>Oregon Water Quality Standards</p> <table><tr><th>Aquatic Life Water Quality Criteria</th><th>Aquatic Life Water Quality Guidance Values</th><th>Human Health Water Quality Criteria</th></tr><tr><th>Freshwater, Chronic (µg/L)</th><th>Freshwater, Chronic (µg/L)</th><th>Water + Organism (µg/L)</th></tr><tr><td>n/a</td><td>n/a</td><td>230</td></tr></table> <p>Source: (DEQ, 2017)</p> <p>Priority Pollutant (EPA's Clean Water Act): Yes TRI-Listed Pollutant (EPA's EPCRA Section 313): No Reportable Pollutant (EPA's CERCLA's Section 304): Yes</p> <p>Sources: (EPA, 2014, 2015, 2016)</p>	Aquatic Life Water Quality Criteria	Aquatic Life Water Quality Guidance Values	Human Health Water Quality Criteria	Freshwater, Chronic (µg/L)	Freshwater, Chronic (µg/L)	Water + Organism (µg/L)	n/a	n/a	230
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Abbreviations / Acronyms	<p>atm-m<sup>3</sup>/mol – atmosphere-cubic meters per mole</p> <p>CASRN – Chemical Abstract Registry Number</p> <p>CERCLA – Comprehensive Environmental Response, Compensation and Liability Act</p> <p>°C – degrees Celsius</p> <p>EPA – Environmental Protection Agency</p> <p>EPCRA – Environmental Planning and Community Right-to-Know Act</p> <p>g/cm<sup>3</sup> – grams per centimeter cubed</p> <p>IUPAC – International Union of Pure and Applied Chemistry</p> <p>L/kg – liters per kilogram</p> <p>log – log base 10 of K (i.e., 10<sup>K</sup>)</p> <p>mmHg – millimeters mercury</p> <p>mol/L – moles per liter</p> <p>n/a – not applicable</p> <p>µg/L – micrograms per liter</p>
References	<p>ATSDR. (1994). Toxicological Profile for 1,1-Dichloroethene. <a href="https://doi.org/10.3109/15569529909037564">https://doi.org/10.3109/15569529909037564</a></p> <p>ATSDR. (2014). Toxicological Profile for Tetrachloroethylene. <a href="https://doi.org/http://www.atsdr.cdc.gov/toxprofiles/tp18.pdf">https://doi.org/http://www.atsdr.cdc.gov/toxprofiles/tp18.pdf</a></p> <p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p> <p>EPA. (2012). Sustainable Futures / P2 Framework Manual 2012 EPA-748-B12-001 Chapter 5 Estimating Physical / Chemical and Environmental Fate Properties with EPI Suite™. Retrieved from <a href="https://www.epa.gov/sites/production/files/2015-05/documents/05.pdf">https://www.epa.gov/sites/production/files/2015-05/documents/05.pdf</a></p> <p>EPA. (2014). Priority Pollutant List. Retrieved from <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a></p> <p>EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <a href="https://www.epa.gov/epcra/epcracerclaa-ss112r-consolidated-list-lists-march-2015-version">https://www.epa.gov/epcra/epcracerclaa-ss112r-consolidated-list-lists-march-2015-version</a></p> <p>EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from <a href="https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf">https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf</a></p> <p>EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <a href="https://comptox.epa.gov/dashboard">https://comptox.epa.gov/dashboard</a></p>

	EPA. (2018). Estimation Programs Interface Suite. Retrieved from <a href="https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface#cite">https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface#cite</a>
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	SRC. (2013). FatePointers Search Module, PhysProp. Retrieved December 1, 2017, from <a href="http://esc.srcinc.com/fatepointer/search.asp">http://esc.srcinc.com/fatepointer/search.asp</a>
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# Toxic Pollutant Profile | 1,2-Dichloroethene (DCE)

Profile	Classification: Volatile Organic Compound (VOC)																																													
	CASRN: 540-59-0																																													
	Molecular Formula: C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>																																													
	IUPAC Name: 1,2-dichloroethene																																													
	Synonyms: 1,2-dichloroethylene																																													
	cis-1,2-DCE	trans-1,2-DCE																																												
	<u>Source:</u> (EPA, 2017)																																													
	<b>Description</b> 1,1-DCE is a clear, colorless liquid that is a man-made chemical and is not found naturally in the environment (primarily used to make other chemicals/products). 1,1-DCE is sometimes found as a mixture and has two isomers: cis-1,2-DCE and trans-1,2-DCE. The trans isomer is most preferred in industrial applications.																																													
	<b>Chemical Characteristics</b>																																													
	<table><tr><td>Toxic Pollutant Isomer</td><td>1,2-DCE (540-59-0)</td><td>cis-1,2-DCE (156-59-2)</td><td>trans-1,2-DCE (156-60-5)</td></tr><tr><td>Molecular Weight (g/mol)</td><td>97</td><td>97</td><td>97</td></tr><tr><td>Density (g/cm<sup>3</sup>)</td><td>1.24 @ 25°C</td><td>1.24 @ 25°C</td><td>1.24 @ 25°C</td></tr><tr><td>Water Solubility (mg/L)</td><td>3,500 @ 25°C</td><td>6,410 @ 25°C</td><td>4,520 @ 25°C</td></tr><tr><td>Boiling Point (°C)</td><td>55</td><td>60</td><td>49</td></tr><tr><td>Melting Point (°C)</td><td>-57</td><td>-81</td><td>-50</td></tr><tr><td>Octanol-water coefficient (log K<sub>ow</sub>)</td><td>2.00</td><td>1.86</td><td>2.09</td></tr><tr><td>Octanol-air coefficient (log K<sub>oa</sub>)</td><td>2.81</td><td>2.81</td><td>2.81</td></tr><tr><td>Soil organic carbon-water coefficient (log K<sub>oc</sub>)</td><td>1.74</td><td>1.69</td><td>1.56</td></tr><tr><td>Vapor Pressure (mmHg)</td><td>201 @ 25°C</td><td>200 @ 25°C</td><td>331 @ 25°C</td></tr><tr><td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td>0.00408 @ 25°C</td><td>0.00408 @ 25°C</td><td>0.00938 @ 25°C</td></tr></table>		Toxic Pollutant Isomer	1,2-DCE (540-59-0)	cis-1,2-DCE (156-59-2)	trans-1,2-DCE (156-60-5)	Molecular Weight (g/mol)	97	97	97	Density (g/cm <sup>3</sup> )	1.24 @ 25°C	1.24 @ 25°C	1.24 @ 25°C	Water Solubility (mg/L)	3,500 @ 25°C	6,410 @ 25°C	4,520 @ 25°C	Boiling Point (°C)	55	60	49	Melting Point (°C)	-57	-81	-50	Octanol-water coefficient (log K <sub>ow</sub> )	2.00	1.86	2.09	Octanol-air coefficient (log K <sub>oa</sub> )	2.81	2.81	2.81	Soil organic carbon-water coefficient (log K <sub>oc</sub> )	1.74	1.69	1.56	Vapor Pressure (mmHg)	201 @ 25°C	200 @ 25°C	331 @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	0.00408 @ 25°C	0.00408 @ 25°C	0.00938 @ 25°C
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Sources	<b>Natural Sources</b> <ul style="list-style-type: none"><li>None</li></ul> <b>Non-natural Sources/Uses:</b> <ul style="list-style-type: none"><li>Manufacturing/processing (produced by direct chlorination of acetylene or dehydrochlorination of 1,1,2-trichloroethane)</li><li>Production of other chlorinated compounds</li><li>Solvent (for waxes, resins, acetylcellulose, perfumes, dyes, lacquers, thermoplastics, fats,</li></ul>																																													

	<ul style="list-style-type: none"> <li>and phenols)</li> <li>• Rubber and decaffeinated coffee extraction</li> <li>• Manufacturing of pharmaceuticals and artificial pearls</li> </ul> <p>Releases to Air Emissions of 1,2-DCE to the atmosphere are reported from manufacturing/production facilities, contaminated wastewaters and disposal sites, and pyrolysis/combustion of polyvinyl chloride, solvent usage and extraction.</p> <p>Releases to Soil Releases of 1,2-DCE to soil are reported from contaminated waste disposal sites and manufacturing/processing facilities. 1,2-DCE can also form in soil from landfills, aquifers, or sediments as anaerobic biodegradation products of other chlorinated solvents.</p> <p>Releases to Water Releases of 1,2-DCE to surface waters and groundwater are reported from contaminated waste disposal sites, wastewater from industrial facilities, municipal wastewater treatment effluent, solvent usage and extraction facilities, petroleum refining, coal mining, foundries, nonferrous metal manufacturing, paint/ink formulations, rubber processing, steam electricity generation, leather tanning, iron and steel manufacturing, plastics and synthetics, electrical components and electronics, pharmaceuticals, and transportation equipment, spills/leachates, and cracked sewer interceptors through infiltration.</p> <p>Source: (ATSDR, 1996)</p>
Transport and Fate	<p>Transformation &amp; Degradation 1,2-DCE is a degradation product of trichloroethene (TCE) (a degradation product of tetrachloroethene [PCE]), which degrades into vinyl chloride, and eventually to ethane.</p> <ul style="list-style-type: none"> <li>• In air, 1,2-DCE is removed predominantly by photochemical reactions with hydroxyl radicals; direct photolysis not considered a significant process in the atmosphere.</li> <li>• In water, 1,2-DCE is removed predominantly by volatilization. In surface water, 1,2-DCE generally resists biodegradation under aerobic conditions (reductive dechlorination is slow).</li> <li>• In soil, anaerobic biodegradation is the predominant mechanism. Chemical hydrolysis, oxidation, and photolysis in water are not considered important fate processes.</li> </ul> <p>Partitioning</p> <ul style="list-style-type: none"> <li>• In air, 1,2-DCE is not expected to partition from the vapor phase to particulates in the atmosphere.</li> <li>• In water, 1,2-DCE is highly volatile from water surfaces, but is also found in groundwater.</li> <li>• In soil, 1,2-DCE is highly volatile from moist soil surfaces and has a low sorption ability, thus able to leach through soil and groundwater.</li> </ul> <p>Bioaccumulation/Bioconcentration Bioconcentration in fish is not expected to be significant. Bioaccumulation in the food chain is not expected to be significant.</p>

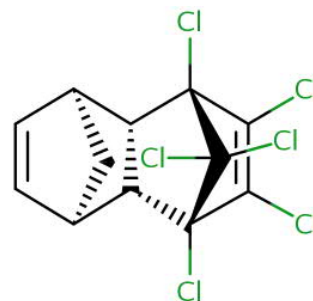
# Toxic Pollutant Profile | 1,2-Dichloroethene (DCE)

	<table><tr><th>Toxic Pollutant</th><th>Bioconcentration Factor (log)</th><th>Bioaccumulation Factor (log)</th></tr><tr><td>1,2-DCE</td><td>n/a</td><td>n/a</td></tr><tr><td>cis-1,2-DCE</td><td>between 5 and 23</td><td>n/a</td></tr><tr><td>trans-1,2-DCE</td><td>between 5 and 23</td><td>n/a</td></tr></table> <p><u>Note:</u> BCF reported for fish</p> <p><u>Sources:</u> (ATSDR, 1994, 1996, 2014)</p>	Toxic Pollutant	Bioconcentration Factor (log)	Bioaccumulation Factor (log)	1,2-DCE	n/a	n/a	cis-1,2-DCE	between 5 and 23	n/a	trans-1,2-DCE	between 5 and 23	n/a				
Toxic Pollutant	Bioconcentration Factor (log)	Bioaccumulation Factor (log)															
1,2-DCE	n/a	n/a															
cis-1,2-DCE	between 5 and 23	n/a															
trans-1,2-DCE	between 5 and 23	n/a															
Water Quality Regulations	<p>Oregon Water Quality Standards</p> <table><tr><th>Toxic Pollutant</th><th>Aquatic Life Water Quality Criteria Freshwater, Chronic (µg/L)</th><th>Aquatic Life Water Quality Guidance Values Freshwater, Chronic (µg/L)</th><th>Human Health Water Quality Criteria Water + Organism (µg/L)</th></tr><tr><td>1,2-DCE</td><td>n/a</td><td>n/a</td><td>n/a</td></tr><tr><td>cis-1,2-DCE</td><td>n/a</td><td>n/a</td><td>n/a</td></tr><tr><td>trans-1,2-DCE</td><td>n/a</td><td>n/a</td><td>120</td></tr></table> <p><u>Source:</u> (DEQ, 2017)</p> <p>Priority Pollutant (EPA's Clean Water Act): Yes (only trans-1,2-DCE) TRI-Listed Pollutant (EPA's EPCRA Section 313): Yes Reportable Pollutant (EPA's CERCLA's Section 304): No</p> <p><u>Sources:</u> (EPA, 2014, 2015, 2016)</p>	Toxic Pollutant	Aquatic Life Water Quality Criteria Freshwater, Chronic (µg/L)	Aquatic Life Water Quality Guidance Values Freshwater, Chronic (µg/L)	Human Health Water Quality Criteria Water + Organism (µg/L)	1,2-DCE	n/a	n/a	n/a	cis-1,2-DCE	n/a	n/a	n/a	trans-1,2-DCE	n/a	n/a	120
Toxic Pollutant	Aquatic Life Water Quality Criteria Freshwater, Chronic (µg/L)	Aquatic Life Water Quality Guidance Values Freshwater, Chronic (µg/L)	Human Health Water Quality Criteria Water + Organism (µg/L)														
1,2-DCE	n/a	n/a	n/a														
cis-1,2-DCE	n/a	n/a	n/a														
trans-1,2-DCE	n/a	n/a	120														
Abbreviations / Acronyms	<p>atm-m<sup>3</sup>/mol – atmosphere-cubic meters per mole</p> <p>CASRN – Chemical Abstract Registry Number</p> <p>CERCLA – Comprehensive Environmental Response, Compensation and Liability Act</p> <p>°C – degrees Celsius</p> <p>DCE – dichloroethylene</p> <p>EPA – Environmental Protection Agency</p> <p>EPCRA – Environmental Planning and Community Right-to-Know Act</p> <p>g/cm<sup>3</sup> – grams per centimeter cubed</p> <p>IUPAC – International Union of Pure and Applied Chemistry</p> <p>L/kg – liters per kilogram</p> <p>log – log base 10 of K (i.e., 10<sup>K</sup>)</p> <p>mmHg – millimeters mercury</p> <p>mol/L – moles per liter</p> <p>n/a – not applicable / not analyzed</p> <p>µg/liter – micrograms per liter</p>																



References	<p>ATSDR. (1994). Toxicological Profile for 1,1-Dichloroethene. <a href="https://doi.org/10.3109/15569529909037564">https://doi.org/10.3109/15569529909037564</a></p> <p>ATSDR. (1996). Toxicological Profile for 1,2-dichloroethene. Retrieved from <a href="https://www.atsdr.cdc.gov/toxprofiles/index.asp#D">https://www.atsdr.cdc.gov/toxprofiles/index.asp#D</a></p> <p>ATSDR. (2014). Toxicological Profile for Tetrachloroethylene. <a href="https://doi.org/http://www.atsdr.cdc.gov/toxprofiles/tp18.pdf">https://doi.org/http://www.atsdr.cdc.gov/toxprofiles/tp18.pdf</a></p> <p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p> <p>EPA. (2014). Priority Pollutant List. Retrieved from <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a></p> <p>EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <a href="https://www.epa.gov/epcra/epcracerclacaa-ss112r-consolidated-list-lists-march-2015-version">https://www.epa.gov/epcra/epcracerclacaa-ss112r-consolidated-list-lists-march-2015-version</a></p> <p>EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from <a href="https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RX_2016_RFI.pdf">https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RX_2016_RFI.pdf</a></p> <p>EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <a href="https://comptox.epa.gov/dashboard">https://comptox.epa.gov/dashboard</a></p> <p>EPA. (2018). Estimation Programs Interface Suite. Retrieved from <a href="https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface#cite">https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface#cite</a></p> <p>SRC. (2013). FatePointers Search Module, PhysProp. Retrieved December 1, 2017, from <a href="http://esc.srcinc.com/fatepointer/search.asp">http://esc.srcinc.com/fatepointer/search.asp</a></p>
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<p>Profile</p>	<p>Classification: Organochlorine Insecticide</p> <p>CASRN: 309-00-2</p> <p>Molecular Formula: C<sub>12</sub>H<sub>8</sub>Cl<sub>6</sub></p> <p>IUPAC Name: 1,2,3,4,10,10-hexachloro1,4,4<math>\alpha</math>,5,8,8<math>\alpha</math>-hexahydro-1,4-endo,exo-5,8-dimethanonaphthalene</p> <p>Synonyms: Isodrin; HHDN</p> <p>Source: (EPA, 2017) (ATSDR, 2002)</p> <p>Description</p> <p>Aldrin is a man-made chemical, existing as a white powder, known as a chlorinated cyclodiene (derived from hexachlorocyclopentadiene). Aldrin was used as an insecticide from 1948 to the 1970s (on crops) and from 1972 to 1987 (on termites). Aldrin was banned in 1974 and completely cancelled as a registered pesticide in 1989.</p> <p>Chemical Characteristics</p> <table border="1"> <tbody> <tr> <td>Molecular Weight (g/mol)</td><td>365</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>1.74 @ 25°C</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>0.011 @ 25°C</td></tr> <tr> <td>Boiling Point (°C)</td><td>decomposes</td></tr> <tr> <td>Melting Point (°C)</td><td>106</td></tr> <tr> <td>Octanol-water coefficient (log K<sub>ow</sub>)</td><td>6.50</td></tr> <tr> <td>Octanol-air coefficient (log K<sub>oa</sub>)</td><td>8.08</td></tr> <tr> <td>Soil organic carbon-water coefficient (log K<sub>oc</sub>)</td><td>5.64</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td>0.00012 @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td>4.90x10<sup>-5</sup> @ 25°C</td></tr> </tbody> </table> <p>Source: (ATSDR, 2002; EPA, 2018)</p> <p>Organic Solvents</p> <p>Very soluble in most organic solvents.</p> <p>Source: (ATSDR, 2002)</p>	Molecular Weight (g/mol)	365	Density (g/cm <sup>3</sup> )	1.74 @ 25°C	Water Solubility (mg/L)	0.011 @ 25°C	Boiling Point (°C)	decomposes	Melting Point (°C)	106	Octanol-water coefficient (log K <sub>ow</sub> )	6.50	Octanol-air coefficient (log K <sub>oa</sub> )	8.08	Soil organic carbon-water coefficient (log K <sub>oc</sub> )	5.64	Vapor Pressure (mmHg)	0.00012 @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	4.90x10 <sup>-5</sup> @ 25°C
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<p>Sources</p>	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>None</li> </ul> <p>Non-natural Sources/Uses:</p> <ul style="list-style-type: none"> <li>Manufacturing/production by the condensation of hexachlorocyclopentadiene with bicycle(2.2.1)-2,5-heptadiene (legacy)</li> <li>Insecticide on crops (citrus, corn), timber, termites (around plastic and rubber coverings around electrical/telecommunication cables and plywood/building boards) (legacy)</li> </ul> <p>Releases to Air</p> <p>Emissions of aldrin to the atmosphere are reported from hazardous waste sites emissions, previously treated soil/crops emissions (i.e., atmospheric dispersal).</p>																				



	<p><b>Releases to Soil</b> Releases of aldrin to soil are reported from contaminated hazardous waste sites, improper disposal from old Aldrin inventory, and wet/dry atmospheric deposition.</p> <p><b>Releases to Water</b> Releases of aldrin to surface waters and groundwater are reported from contaminated hazardous waste sites and stormwater runoff from cropland.</p> <p><u>Source:</u> (ATSDR, 2002)</p>									
Transport and Fate	<p><b>Transformation &amp; Degradation</b> Aldrin degrades to dieldrin.</p> <ul style="list-style-type: none"><li>• In the atmosphere, the vapor phase of Aldrin can photodegrade to photoaldrin (a stereoisomer of aldrin) via reaction with photochemically-produced hydroxy radicals. Aldrin can also degrade with ozone and nitrogen dioxide reactions. The particulate phase of aldrin in the atmosphere will not participate in hydroxyl radical reactions.</li><li>• In active wastewater sludge, Aldrin can be degraded under anaerobic conditions. In water, Aldrin undergoes little degradation, except in the presence of amino/humic acids.</li><li>• In soil, Aldrin degrades by epoxidation in aerobic and biologically active soils and can undergo degradation by ultraviolet light to form photodieldrin.</li></ul> <p><b>Partitioning</b> Aldrin is not found in water in high concentrations; it evaporates readily from surface water and soil surfaces and it sorbs strongly to soil particles.</p> <ul style="list-style-type: none"><li>• In air, aldrin will exist in both vapor and particulate phases in the atmosphere and can undergo atmospheric transport and dry/wet atmospheric deposition.</li><li>• In water, aldrin is expected to volatilize, but may be attenuated by the presence of adsorption to suspended solids and sediment in the water column. Aldrin is not present in groundwater.</li><li>• In soil, aldrin is expected to be immobile (due to its high soil adsorption ability). However, mobility can increase in soil with the presence of organic solvents (increases water solubility). Volatilization from soil is expected to be rapid (at the surface). Aldrin is resistant to leaching.</li></ul> <p><b>Bioaccumulation/Bioconcentration</b> Aldrin has a high potential for bioaccumulation and bioconcentration in terrestrial and aquatic organisms and terrestrial ecosystems. Aldrin rapidly degrades to dieldrin, which can rapidly bioaccumulate and bioconcentrate.</p> <table><tr><th>Bioconcentration Factor</th><th>Bioaccumulation Factor</th></tr><tr><td>3,490 to 20,000</td><td>n/a</td></tr></table> <p><u>Note:</u> BCF reported for fish</p> <p><u>Source:</u> (ATSDR, 2002)</p>	Bioconcentration Factor	Bioaccumulation Factor	3,490 to 20,000	n/a					
Bioconcentration Factor	Bioaccumulation Factor									
3,490 to 20,000	n/a									
Regulations	<p><b>Oregon Water Quality Standards</b></p> <table><tr><th>Aquatic Life Water Quality Criteria</th><th>Aquatic Life Water Quality Guidance Values</th><th>Human Health Water Quality Criteria</th></tr><tr><td>Freshwater, Chronic (µg/L)</td><td>Freshwater, Chronic (µg/L)</td><td>Water + Organism (µg/L)</td></tr><tr><td>n/a</td><td>n/a</td><td>0.000005</td></tr></table> <p><u>Source:</u> (DEQ, 2017)</p>	Aquatic Life Water Quality Criteria	Aquatic Life Water Quality Guidance Values	Human Health Water Quality Criteria	Freshwater, Chronic (µg/L)	Freshwater, Chronic (µg/L)	Water + Organism (µg/L)	n/a	n/a	0.000005
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	<p>Priority Pollutant (EPA's Clean Water Act): Yes          TRI-Listed Pollutant (EPA's EPCRA Section 313): Yes          Reportable Pollutant (EPA's CERCLA's Section 304): Yes</p> <p>Sources: (EPA, 2014, 2015, 2016)</p>
Abbreviations / Acronyms	<p>atm-m<sup>3</sup>/mol – atmosphere-cubic meters per mole          CASRN – Chemical Abstract Registry Number          CERCLA – Comprehensive Environmental Response, Compensation and Liability Act          °C – degrees Celsius          EPA – Environmental Protection Agency          EPCRA – Environmental Planning and Community Right-to-Know Act          g/cm<sup>3</sup> – grams per centimeter cubed          IUPAC – International Union of Pure and Applied Chemistry          L/kg – liters per kilogram          log – log base 10 of K (i.e., 10<sup>K</sup>)          mol/L – moles per liter          mmHg – millimeters mercury          n/a – not available / not analyzed          µg/liter – micrograms per liter</p>
References	<p>ATSDR. (2002). Toxicological Profile for Aldrin / Dieldrin. Retrieved from <a href="https://www.atsdr.cdc.gov/toxprofiles/index.asp#D">https://www.atsdr.cdc.gov/toxprofiles/index.asp#D</a></p> <p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p> <p>EPA. (2014). Priority Pollutant List. Retrieved from <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a></p> <p>EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <a href="https://www.epa.gov/epcra/epcracerclacaa-ss112r-consolidated-list-lists-march-2015-version">https://www.epa.gov/epcra/epcracerclacaa-ss112r-consolidated-list-lists-march-2015-version</a></p> <p>EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from <a href="https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf">https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf</a></p> <p>EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <a href="https://comptox.epa.gov/dashboard">https://comptox.epa.gov/dashboard</a></p> <p>EPA. (2018). Estimation Programs Interface Suite. Retrieved from <a href="https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface#citing">https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface#citing</a></p>

<p>Profile</p>	<div> <div>Classification: Volatile Organic Compound</div> <div>CASRN: 7664-41-7</div> <div>Molecular Formula: NH<sub>3</sub></div> <div>IUPAC Name: Ammonia</div> <div>Synonyms: none</div> <div>Source: (EPA, 2017)</div> </div> <div> <div>Description</div> <div>Ammonia occurs naturally in the environment as a chemical reaction between nitrogen and hydrogen. Ammonia is found as a colorless gas (anhydrous ammonia) but can also be compressed to become a liquid. Ammonia occurs naturally as a breakdown of manure and dead plants/animals but is also industrially manufactured.</div> <div>Chemical Characteristics</div> <table> <tr> <td>Molecular Weight (g/mol)</td><td>17</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>n/a</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>482,000 @ 25°C</td></tr> <tr> <td>Boiling Point (°C)</td><td>33</td></tr> <tr> <td>Melting Point (°C)</td><td>-78</td></tr> <tr> <td>Octanol-water partitioning coefficient (log K<sub>ow</sub>)</td><td>0.230</td></tr> <tr> <td>Octanol-air partitioning coefficient (log K<sub>oa</sub>)</td><td>1.80</td></tr> <tr> <td>Soil organic carbon-water partitioning coefficient (log K<sub>oc</sub>)</td><td>-1.20</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td>7,508 @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td>1.60x10<sup>-5</sup> @ 25°C</td></tr> </table> <div>Sources: (ATSDR, 2004; EPA, 2018; SRC, 2013)</div> <div>Organic Solvents</div> <div>Soluble ethanol, methanol, and chloroform. Soluble in water.</div> <div>Sources: (ATSDR, 2004; NLM, 2017)</div> </div>	Molecular Weight (g/mol)	17	Density (g/cm <sup>3</sup> )	n/a	Water Solubility (mg/L)	482,000 @ 25°C	Boiling Point (°C)	33	Melting Point (°C)	-78	Octanol-water partitioning coefficient (log K <sub>ow</sub> )	0.230	Octanol-air partitioning coefficient (log K <sub>oa</sub> )	1.80	Soil organic carbon-water partitioning coefficient (log K <sub>oc</sub> )	-1.20	Vapor Pressure (mmHg)	7,508 @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	1.60x10 <sup>-5</sup> @ 25°C
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<p>Sources</p>	<div>Natural Sources</div> <ul style="list-style-type: none"> <li>Breakdown of manure and dead animals/plants</li> </ul> <div>Non-natural Sources &amp; Uses:</div> <ul style="list-style-type: none"> <li>Manufacturing</li> <li>Byproduct of coal coking</li> <li>Agricultural (fertilizers)</li> <li>Plastics, resins, synthetic fibers</li> <li>Explosives</li> <li>Corrosion inhibitor</li> <li>Water purification</li> <li>Household cleaners</li> <li>Refrigerant</li> <li>Pharmaceuticals</li> </ul>																				

	<ul style="list-style-type: none"> <li>Chemical intermediates</li> </ul> <p><b>Releases to Air</b> Emissions of ammonia are reported from production processes and consumptive use, including agricultural use (fertilizer and sewage sludge application), venting from production and transport, formulation/incorporation into secondary byproducts, and tank leaks, volatilization from wastewaters at industrial facilities and wastewater treatment plants. Natural sources include emissions from animal manure and decaying plants/animals, volcanic eruptions, and forest fires.</p> <p><b>Releases to Soil</b> Releases of ammonia to soil are reported from production processes and consumptive use, including agricultural (fertilizer and sewage sludge application), and releases from hazardous waste sites and landfills. Natural sources of ammonia include atmospheric deposition, microbial fixation of nitrogen from the atmosphere and microorganisms, and decaying plants/animals</p> <p><b>Releases to Water</b> Releases of ammonia to surface waters are reported from production processes and consumptive use including wastewater effluent (industrial/municipal), and agricultural runoff, releases from hazardous waste sites and landfills. Natural sources include atmospheric deposition and decomposing cyanobacteria.</p> <p><u>Source:</u> (ATSDR, 2004)</p>
<p>Transport and Fate</p>	<p><b>Transformation &amp; Degradation</b> Ammonia is an important chemical in the environment and organisms contribute to the transformation and degradation processes for various life cycles. Ammonia is a base and is thus pH-dependent.</p> <ul style="list-style-type: none"> <li>In air, ammonia predominantly reacts with acid air pollutants, forming particulate nitrate compounds by reacting with nitric acid and sulfuric acid, dependent on concentration. Ammonia can react in the vapor phase with photochemically produced hydroxyl radicals.</li> <li>In water, ammonia can undergo transformations in the nitrogen cycle (nitrification and denitrification), producing ionic nitrogen compounds and then elemental nitrogen. Ionic nitrogen compounds are able to leach through soil. Ammonia can be taken up by plants. Ammonia is in equilibrium with ammonium, dependent on pH and temperature (ammonium favored in acidic water).</li> <li>In soil, ammonia can be transformed to nitrate by microbes through nitrification, which can leach through soil or be taken up by plants. In plants, it is converted to organic nitrogen compounds.</li> </ul> <p><b>Partitioning</b> The transport and partitioning of ammonia is dependent on pH, temperature, and the environmental media.</p> <ul style="list-style-type: none"> <li>In air, ammonia is the predominant basic gas and is capable of reacting readily with sulfuric acid, nitric acid, and hydrogen chloride. Ammonia can be transported long distances and undergo dry/wet atmospheric deposition, with the type of deposition dependent on the presence of ammonia or ammonium.</li> <li>In water, ammonia can volatilize from surface water and be taken up by plants. The rate of volatilization increases with pH and temperature. Ammonia is very soluble in water.</li> <li>In soil, sorption of ammonia to sediment and organic material is important under critical</li> </ul>

	<p>conditions, and increases with organic content, metal ion content, and decreasing pH. Adsorption occurs in moist or dry soils and sorbs strongly to solid particles (soil, sediment, organic matter). Ammonia is usually in the form of ammonia ion existing in soil as nitrate that binds to soil particles. As such, ammonia does not readily leach in soil to groundwater. Nitrate (derived from ammonia) may leach to groundwater.</p> <p>Bioaccumulation/Bioconcentration Bioaccumulation of ammonia does not occur given its natural process in the nitrogen cycle (and low Kow). Ammonia is rapidly taken up by plants and bioconverted.</p> <p>Source: (ATSDR, 2004)</p>									
Water Quality Regulations	<p>Oregon Water Quality Standards</p> <table><tr><th>Aquatic Life Water Quality Criteria</th><th>Aquatic Life Water Quality Guidance Values</th><th>Human Health Water Quality Criteria</th></tr><tr><th>Freshwater, Chronic (µg/L)</th><th>Freshwater, Chronic (µg/L)</th><th>Water + Organism (µg/L)</th></tr><tr><td>Calculated as function of pH and temperature</td><td>n/a</td><td>n/a</td></tr></table> <p>Source: (DEQ, 2017)</p> <p>Priority Pollutant (EPA’s Clean Water Act): Yes TRI-Listed Pollutant (EPA’s EPCRA Section 313): Yes Reportable Pollutant (EPA’s CERCLA’s Section 304): Yes (only fume, dust, and compounds)</p> <p>Sources: (EPA, 2014, 2015, 2016)</p>	Aquatic Life Water Quality Criteria	Aquatic Life Water Quality Guidance Values	Human Health Water Quality Criteria	Freshwater, Chronic (µg/L)	Freshwater, Chronic (µg/L)	Water + Organism (µg/L)	Calculated as function of pH and temperature	n/a	n/a
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Abbreviations / Acronyms	<p>atm-m<sup>3</sup>/mol – atmosphere-cubic meters per mole</p> <p>CASRN – Chemical Abstract Registry Number</p> <p>CERCLA – Comprehensive Environmental Response, Compensation and Liability Act</p> <p>°C – degrees Celsius</p> <p>EPA – Environmental Protection Agency</p> <p>EPCRA – Environmental Planning and Community Right-to-Know Act</p> <p>g/cm<sup>3</sup> – grams per centimeter cubed</p> <p>IUPAC – International Union of Pure and Applied Chemistry</p> <p>L/kg – liters per kilogram</p> <p>log – log base 10 of K (i.e., 10<sup>K</sup>)</p> <p>mm Hg – millimeters mercury</p> <p>mol/L – moles per liter</p> <p>n/a – not available / not analyzed</p> <p>µg/liter – micrograms per liter</p>									
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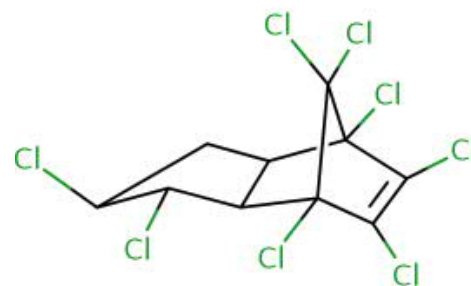
<p>Profile</p>	<div> <div>Classification: metal</div> <div>CASRN: 7440-38-2</div> <div>Molecular Formula: As</div> <div>IUPAC Name: Arsenic</div> <div>Synonyms: n/a</div> <div>Source: (EPA, 2017)</div> </div> <div> <div>Description</div> <div> <p>Arsenic is a shiny silver-gray or tin-white solid element that occurs naturally in the environment, mostly in the form of metallic arsenides. Other inorganic compounds include: arsenic acid, arsenic pentoxide, arsenic trioxide, calcium arsenate, gallium arsenide, disodium arsenate, sodium arsenite, arsenilic acid, arsenobetaine, dimethylarsinic acid, methanearsonic acid, 3-nitro-4-hydroxy-phenylarsonic acid, sodium arsanitate, disodium methanearsonate, sodium dimethylarsinate, and sodium methanearsonate.</p> </div> </div> <div> <div>Chemical Characteristics</div> <table border="1"> <tbody> <tr> <td>Molecular Weight (g/mol)</td><td>78</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>5.78 @ 25°C</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>34,710</td></tr> <tr> <td>Boiling Point (°C)</td><td>614</td></tr> <tr> <td>Melting Point (°C)</td><td>817</td></tr> <tr> <td>Octanol-water coefficient (log K<sub>ow</sub>)</td><td>0.680</td></tr> <tr> <td>Octanol-air coefficient (log K<sub>oa</sub>)</td><td>-0.820</td></tr> <tr> <td>Soil organic carbon-water coefficient (log K<sub>oc</sub>)</td><td>0.590</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td>7.5x10<sup>-3</sup> @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td>0.773 @ 25°C</td></tr> </tbody> </table> <div>Sources: (ATSDR, 2015; EPA, 2018; SRC, 2013)</div> </div> <div> <div>Organic Solvents</div> <div>Arsenic is insoluble in water as well as in caustic and non-oxidizing acids.</div> <div>Source: (ATSDR, 2015)</div> </div>	Molecular Weight (g/mol)	78	Density (g/cm <sup>3</sup> )	5.78 @ 25°C	Water Solubility (mg/L)	34,710	Boiling Point (°C)	614	Melting Point (°C)	817	Octanol-water coefficient (log K <sub>ow</sub> )	0.680	Octanol-air coefficient (log K <sub>oa</sub> )	-0.820	Soil organic carbon-water coefficient (log K <sub>oc</sub> )	0.590	Vapor Pressure (mmHg)	7.5x10 <sup>-3</sup> @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	0.773 @ 25°C
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<p>Sources</p>	<div> <div>Natural Sources</div> <ul style="list-style-type: none"> <li>Minerals/ores that contain copper and lead (byproduct of the smelting of copper, lead, cobalt, and gold ores)</li> <li>Volcanoes</li> <li>Sea water and vegetation</li> </ul> </div> <div> <div>Non-natural Sources &amp; Uses:</div> <ul style="list-style-type: none"> <li>Wood preservative (chromated copper arsenate [CCA])</li> <li>Herbicides (turf/weeds), fungicide (grapes), pesticides (fruit orchards/potatoes, ants), desiccant (okra and cotton)</li> <li>Alloying element in ammunition and solders (elemental As)</li> <li>Anti-friction additive to metals for bearings</li> </ul> </div>																				

	<ul style="list-style-type: none"> <li>• Strengtheners of lead-acid storage battery grids</li> <li>• Antimicrobial for animal and poultry feeds</li> <li>• Treatment of acute promyelocytic leukemia</li> <li>• Electronic components (relays, switches, circuit boards, semi-conductors)</li> </ul> <p><b>Releases to Air</b> Emissions of arsenic to the atmosphere are reported from manufacturing/processing facilities, nonferrous metal smelting, coal, oil, and wood combustion, municipal waste incineration, ash from power plants, and agricultural application. Emissions of arsenic to the atmosphere from natural sources include volcanoes, sea salt spray, and forest fires.</p> <p><b>Releases to Soil</b> Releases of arsenic to soil are reported from manufacturing/processing facilities, underground injection, ash residue from power plants, smelting operations (slag), mining wastes (tailings), and municipal/commercial/industrial wastes, leaching of arsenic-contaminated ash in cement roads/construction material, leaching from slag deposits, soil, CCA-treated wood, and contaminated landfills, and poultry farms, pesticide/fertilizer applications, infiltration of stormwater runoff, and land application of arsenic-contaminated sewage sludge. Releases of arsenic to soil from natural sources include atmospheric deposition and volcanic areas.</p> <p><b>Releases to Water</b> Releases of arsenic to surface waters and groundwater are reported from manufacturing/processing facilities, mining and mine tailings (gold-milling using cyanide), nonferrous metals smelting (copper), wastewater treatment plants, stormwater runoff, farms/agricultural fields, smelters, hazardous waste sites, sewage dumping, leaching from slag deposits, soil, CCA-treated wood, and contaminated landfills, and poultry farms. Releases of arsenic to surface waters from natural sources include the natural weathering of soil/rocks, volcanic areas, and atmospheric deposition.</p> <p><u>Source:</u> (ATSDR, 2015)</p>
<p><b>Transport and Fate</b></p>	<p><b>Transformation &amp; Degradation</b></p> <ul style="list-style-type: none"> <li>• Arsenic is released to the atmosphere as arsenic trioxide or arsine (a volatile organic compound) and can be in several forms in the atmosphere. Degradation by photolysis is not significant. Arsenic can undergo long-range transport in the atmosphere and dry/wet atmospheric deposition.</li> <li>• In water, arsenic can undergo a series of transformations influenced by: pH, temperature, and salinity. Some pesticides do not degrade by hydrolysis. Inorganic species of arsenic are predominant in water. Aquatic microorganism can reduce and methylate arsenic species.</li> <li>• In soil, arsenic is a complex mixture of mineral phases (sorbed and dissolved) dependent on particle size, presence of other minerals in soil, soil type, and soil pH.</li> </ul> <p><b>Partitioning</b> Arsenic compounds tend to partition to soil particles (under oxidizing conditions) and is found naturally in the soil and rocks.</p> <ul style="list-style-type: none"> <li>• In air, arsenic partitions to particulate matter.</li> <li>• In water, partitioning and transport of arsenic depends on the chemical form and on interactions with other materials present. Soluble forms move with water but can also be adsorbed onto soils/sediments. Arsenic in the water column may be resuspended</li> </ul>

	<p>sediment.</p> <ul style="list-style-type: none"><li>• In soil, arsenic is immobile in agricultural soils. Soil sorption and migration (leaching) is dependent on soil type (dependent on pH) and amount of dissolved organic matter. Arsenic can be released under reducing conditions in the presence of other minerals (i.e., iron and manganese oxides), which can occur in wet conditions. Volatilization (evaporation) does not occur with arsenic compounds.</li></ul> <p>Bioaccumulation/Bioconcentration</p> <p>Some marine algae and shellfish tend to bioconcentrate arsenic and predators may bioaccumulate arsenic from surrounding water and feeding on other fish. BCF/BAF concentrations are a function of arsenic concentrations in water.</p> <table><tr><th>Bioconcentration Factor</th><th>Bioaccumulation Factor</th></tr><tr><td>Between 200 and 8,700</td><td>n/a</td></tr></table> <p>Note: BCF reported for fish</p> <p>Source: (ATSDR, 2015)</p>	Bioconcentration Factor	Bioaccumulation Factor	Between 200 and 8,700	n/a					
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	<p>n/a – not available / not analyzed</p> <p>µg/liter – micrograms per liter</p>
References	<p>ATSDR. (2015). Addendum to the Toxicological Profile for Arsenic. Retrieved from <a href="https://www.atsdr.cdc.gov/toxprofiles/index.asp#D">https://www.atsdr.cdc.gov/toxprofiles/index.asp#D</a></p> <p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p> <p>EPA. (2014). Priority Pollutant List. Retrieved from <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a></p> <p>EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <a href="https://www.epa.gov/epcra/epcracerclaa-ss112r-consolidated-list-lists-march-2015-version">https://www.epa.gov/epcra/epcracerclaa-ss112r-consolidated-list-lists-march-2015-version</a></p> <p>EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from <a href="https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf">https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf</a></p> <p>EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <a href="https://comptox.epa.gov/dashboard">https://comptox.epa.gov/dashboard</a></p> <p>EPA. (2018). Estimation Programs Interface Suite. Retrieved from <a href="https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface#citing">https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface#citing</a></p> <p>SRC. (2013). FatePointers Search Module, PhysProp. Retrieved December 1, 2017, from <a href="http://esc.srcinc.com/fatepointer/search.asp">http://esc.srcinc.com/fatepointer/search.asp</a></p>

<p>Profile</p>	<p>Classification: Organochlorine Insecticide</p> <p>CASRN: 57-74-9</p> <p>Molecular Formula: <math>C_{10}H_6Cl_8</math></p> <p>IUPAC Name: 1,2,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methano-1H-indene</p> <p>Synonyms: Chlordan; gamma-Chlordane</p> <p>Sources: (ATSDR, 1994; EPA, 2017)</p> <p>Description</p> <p>Chlordane is a man-made chemical, existing as a colorless to amber-color liquid. Chlordane is a mixture of about ten major components, including cis-chlordane, trans-chlordane, and heptachlor. Chlordane was used as a pesticide from 1948 until it was banned in 1988.</p> <p>Chemical Characteristics</p> <table border="1"> <tr> <td>Molecular Weight (g/mol)</td><td>410</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>1.83 @ 25°C</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>0.056 @ 25°C</td></tr> <tr> <td>Boiling Point (°C)</td><td>decomposes</td></tr> <tr> <td>Melting Point (°C)</td><td>107</td></tr> <tr> <td>Octanol-water coefficient (log <math>K_{ow}</math>)</td><td>5.54</td></tr> <tr> <td>Octanol-air coefficient (log <math>K_{oa}</math>)</td><td>9.58</td></tr> <tr> <td>Soil organic carbon-water coefficient (log <math>K_{oc}</math>)</td><td>5.35</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td><math>9.75E10^{-6}</math> @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td><math>4.86E10^{-5}</math> @ 25°C</td></tr> </table> <p>Sources: (ATSDR, 1994; EPA, 2018; SRC, 2013)</p> <p>Organic Solvents</p> <p>Miscible with hydrocarbon solvents</p> <p>Source: (ATSDR, 1994)</p>	Molecular Weight (g/mol)	410	Density (g/cm <sup>3</sup> )	1.83 @ 25°C	Water Solubility (mg/L)	0.056 @ 25°C	Boiling Point (°C)	decomposes	Melting Point (°C)	107	Octanol-water coefficient (log $K_{ow}$ )	5.54	Octanol-air coefficient (log $K_{oa}$ )	9.58	Soil organic carbon-water coefficient (log $K_{oc}$ )	5.35	Vapor Pressure (mmHg)	$9.75E10^{-6}$ @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	$4.86E10^{-5}$ @ 25°C
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<p>Sources</p>	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>None</li> </ul> <p>Non-natural Sources &amp; Uses:</p> <ul style="list-style-type: none"> <li>Manufacturing/production by chlorinating cyclopentadiene to form hexachlorocyclopentadiene to form chlordane, and further chlorinated to form chlordane (currently still produced for export outside U.S.A.)</li> <li>Pesticide on agricultural crops (citrus, corn), lawns, and gardens/turf (prior to 1978)</li> <li>Fumigating agent (prior to 1978)</li> <li>Insecticide on termites in home foundations (1983 to 1988)</li> </ul> <p>Releases to Air</p> <p>Emissions of chlordane to the atmosphere are reported from manufacturing/processing facilities, volatilization from soil and water, and wind erosion.</p>																				



	<p><b>Releases to Soil</b> Releases of chlordane to soil are reported from direct application.</p> <p><b>Releases to Water</b> Releases of chlordane to surface waters and groundwater are reported from stormwater runoff from contaminated soils.</p> <p><u>Source: (ATSDR, 1994)</u></p>								
Transport and Fate	<p><b>Transformation &amp; Degradation</b> Chlordane breaks down to heptachlor, which breaks down to heptachlor epoxide and 1-hydroxychlordene.</p> <ul style="list-style-type: none"> <li>In the atmosphere, chlordane degrades by photolysis and oxidation. The trans-chlordane isomer photochemically degrades more readily than the cis-chlordane. Chlordane also degrades by hydroxy radical reactions.</li> <li>In water, chlordane's transformation reactions are not well studied. However, chlordane will not degrade rapidly in water (suggesting transport is a faster removal mechanism).</li> <li>In soil, chlordane is slow to breakdown, indicating that little chemical or biochemical transformations occur and persist in heavy soils with high organic content.</li> </ul> <p><b>Partitioning</b> Chlordane partitions primarily to soil/sediment but also volatilizes rapidly from surfaces.</p> <ul style="list-style-type: none"> <li>In the atmosphere, chlordane exists predominantly in the vapor phase. Chlordane is found on particulate matter at lower concentrations but can undergo long-range transport and dry/wet atmospheric deposition.</li> <li>In water, chlordane will adsorb to bed and suspended sediments (correlated to the dissolved organic content). Chlordane can repartition in the water. Chlordane will volatilize from the surface rapidly, but is dependent on the percent of organic matter of the suspended material in the water (attenuating the rate of volatilization). Volatilization may be faster than adsorption.</li> <li>In soil, chlordane adsorbs to organic matter and volatilizes slowly over time (dependent mostly on soil moisture and other factors). Chlordane does not leach significantly, remaining in the top layers of soil for long periods of time (dependent on the soil composition). Leaching to groundwater can occur in soil with high organic content.</li> </ul> <p><b>Bioaccumulation/Bioconcentration</b> Chlordane bioconcentrates in marine and fresh water species as well as bacteria. Concentrations of cis-chlordane and trans-chlordane isomers decrease in higher trophic levels. Chlordane is taken up by rooted aquatic plants (from both water and sediment). The composition of chlordane differs and is complex as it bioaccumulates in the food chain</p> <table border="1"> <thead> <tr> <th>Bioconcentration Factor</th><th>Bioaccumulation Factor</th></tr> </thead> <tbody> <tr> <td>Marine: Between 3,000 and 12,000</td><td>Fish to seal: 7.3 / 4.7</td></tr> <tr> <td>Fresh water: 18,500</td><td>Seal to bear: 6.6 / 9.5</td></tr> <tr> <td>Bacteria: Between 200 and 55,900</td><td>Overall fish to bear: 44.2</td></tr> </tbody> </table> <p><u>Note:</u> BCF and BAF values reported for fish</p>	Bioconcentration Factor	Bioaccumulation Factor	Marine: Between 3,000 and 12,000	Fish to seal: 7.3 / 4.7	Fresh water: 18,500	Seal to bear: 6.6 / 9.5	Bacteria: Between 200 and 55,900	Overall fish to bear: 44.2
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	<p><u>Limitations on Fate and Transport</u></p> <p>There is a lack of data on the environmental fate and transformation of chlordane. Chlordane’s degradation products in soil are not reported in the literature. Photolysis, photooxidation, and biodegradation of particulate-bound chlordane are unknown.</p> <p><u>Source:</u> (ATSDR, 1994, 2007)</p>									
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- EPA. (2014). Priority Pollutant List. Retrieved from <https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf>
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- SRC. (2013). FatePointers Search Module, PhysProp. Retrieved December 1, 2017, from <http://esc.srcinc.com/fatepointer/search.asp>



<p>Profile</p>	<p>Classification: Organophosphorus Insecticide</p> <p>CASRN: 2921-88-2</p> <p>Molecular Formula: C<sub>9</sub>H<sub>11</sub>Cl<sub>3</sub>NO<sub>3</sub>PS</p> <p>IUPAC Name: O,O-Diethyl O-(3,5,6-trichloropyridin-2-yl) phosphorothioate</p> <p>Synonyms: Chlorpyrifos; Dursban; Trichlorophyrphos</p> <p>Sources: (EPA, 2017; NLM, 2017)</p> <p>Description</p> <p>Chlorpyrifos is a man-made chemical, existing as a white crystal-like solid, and used as an insecticide since 1965. Chlorpyrifos was withdrawn from most indoor and pet uses in 1997.</p> <p>Chemical Characteristics</p> <table border="1"> <tr> <td>Molecular Weight (g/mol)</td><td>351</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>1.48 @ 25°C</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>2.00 @ 25°C</td></tr> <tr> <td>Boiling Point (°C)</td><td>160</td></tr> <tr> <td>Melting Point (°C)</td><td>42</td></tr> <tr> <td>Octanol-water coefficient (log K<sub>ow</sub>)</td><td>4.82</td></tr> <tr> <td>Octanol-air coefficient (log K<sub>oa</sub>)</td><td>10.6</td></tr> <tr> <td>Soil organic carbon-water coefficient (log K<sub>oc</sub>)</td><td>3.90</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td>1.87x10<sup>-5</sup> @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td>1.23x10<sup>-5</sup> @ 25°C</td></tr> </table> <p>Sources: (ATSDR, 1997; EPA, 2018)</p> <p>Organic Solvents</p> <p>Soluble in isooctane (79%) and methanol (43%) and readily soluble in other organic solvents.</p> <p>Source: (ATSDR, 1997)</p>	Molecular Weight (g/mol)	351	Density (g/cm <sup>3</sup> )	1.48 @ 25°C	Water Solubility (mg/L)	2.00 @ 25°C	Boiling Point (°C)	160	Melting Point (°C)	42	Octanol-water coefficient (log K <sub>ow</sub> )	4.82	Octanol-air coefficient (log K <sub>oa</sub> )	10.6	Soil organic carbon-water coefficient (log K <sub>oc</sub> )	3.90	Vapor Pressure (mmHg)	1.87x10 <sup>-5</sup> @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	1.23x10 <sup>-5</sup> @ 25°C
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<p>Sources:</p>	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>None</li> </ul> <p>Non-natural Sources &amp; Uses:</p> <ul style="list-style-type: none"> <li>Manufacturing/production by reacting 3,5,6-trichloro-2-pyridinol (TCP) and O,O-diethylphosphorochloridothioate in dimethylformamide.</li> <li>Insecticide and acaricide for indoor and outdoor pests (including termites) and treatment of crops, lawns, ornamental plants, domestic animals, and building structures (replaced chlordane and other chlorinated cyclodiene termiticides).</li> <li>Pesticide for crops (including alfalfa, cotton, corn, fruit trees)</li> <li>Foliar and soil applicant for crops (sorghum, soybeans, sugar beets, sunflowers, peanuts)</li> </ul> <p>Releases to Air</p> <p>Emissions of chlorpyrifos to the atmosphere are expected from agricultural applications. Reported releases are not known because it is not a chemical required to be reported to EPA's Toxic Release Inventory (TRI) program.</p>																				



	<p><b>Releases to Soil</b> Releases of chlorpyrifos to soil are expected from direct application on land, leaching from pesticide disposal and hazardous waste sites, and atmospheric deposition. Reported releases are not known because it is not a chemical required to be reported to EPA's TRI program.</p> <p><b>Releases to Water</b> Releases of chlorpyrifos to surface waters and groundwater are manufacturing/production discharges, stormwater runoff from direct application on land, leaching from pesticide disposal and hazardous waste sites, and atmospheric deposition, in addition to spills from transport/storage. Reported releases are not known because it is not a chemical required to be reported to EPA's TRI program.</p> <p><u>Source:</u> (ATSDR, 1997)</p>
<p><b>Transport and Fate</b></p>	<p><b>Transformation &amp; Degradation</b> Chlorpyrifos degrades to 3,5,6-trichloro-2-pyridinol (TCP) plus diethyl thiophosphate.</p> <ul style="list-style-type: none"> <li>• In air, Chlorpyrifos is susceptible to photodegradation by sunlight and reactions with hydroxyl radicals.</li> <li>• In water, chlorpyrifos can degrade under abiotic hydrolysis and photosensitized oxidation. Photodegradation is dependent on the pH of the water (below pH 9) and the amount of soil particles/sediment present in the water. Chlorpyrifos volatilizes from water rapidly and is dependent on the water temperature; therefore, is not persistent in water. Abiotic processes predominate in estuarine systems.</li> <li>• In soil, chlorpyrifos can undergo photo-induced reactions at the surface and transform by abiotic hydrolysis and microbial degradation. Transformations are dependent on soil type (likely due to pH) and temperature. Chlorpyrifos is resistant to enhanced degradation by microbes (i.e., not catabolized).</li> </ul> <p><b>Partitioning</b> Chlorpyrifos is found in small amounts in water and will readily volatilize from surface water. Chlorpyrifos will strongly sorb to soil particles.</p> <ul style="list-style-type: none"> <li>• In air, chlorpyrifos will exist in the vapor phase, but will also partition to available particles. Chlorpyrifos can undergo atmospheric transport and dry atmospheric deposition (depending on the available airborne particulates); however, wet atmospheric deposition is not as important as a process (due to its low solubility).</li> <li>• In water, chlorpyrifos can volatilize, but slowly (due to its low Henry's law constant). Volatility from water is reduced by the presence of soil particles in the water column, where it strongly adsorbs to suspended solids and sediments.</li> <li>• In soil, chlorpyrifos has little mobility and is thus, not able to readily leach into groundwater. Transport processes for chlorpyrifos are affected by soil cultivation practices.</li> </ul> <p><b>Bioaccumulation/Bioconcentration</b> Chlorpyrifos bioconcentrates to varying degrees in different organisms, different doses, and different exposure durations. Chlorpyrifos can biotransfer from plants (BAF in plants has not been published in the literature).</p>

	<table><tr><th>Bioconcentration Factor</th><th>Bioaccumulation Factor</th></tr><tr><td>Between 1 and 5,100</td><td>n/a</td></tr></table> <p><u>Note:</u> BCF reported for fish</p> <p><u>Source:</u> (ATSDR, 1997)</p>	Bioconcentration Factor	Bioaccumulation Factor	Between 1 and 5,100	n/a					
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Water Quality Regulations	<p>Oregon Water Quality Standards</p> <table><tr><th>Aquatic Life Water Quality Criteria</th><th>Aquatic Life Water Quality Guidance Values</th><th>Human Health Water Quality Criteria</th></tr><tr><th>Freshwater, Chronic (µg/L)</th><th>Freshwater, Chronic (µg/L)</th><th>Water + Organism (µg/L)</th></tr><tr><td>0.041</td><td>n/a</td><td>n/a</td></tr></table> <p><u>Source:</u> (DEQ, 2017)</p> <p>Priority Pollutant (EPA's Clean Water Act): No TRI-Listed Pollutant (EPA's EPCRA Section 313): No Reportable Pollutant (EPA's CERCLA's Section 304): Yes</p> <p><u>Sources:</u> (EPA, 2014, 2015, 2016)</p>	Aquatic Life Water Quality Criteria	Aquatic Life Water Quality Guidance Values	Human Health Water Quality Criteria	Freshwater, Chronic (µg/L)	Freshwater, Chronic (µg/L)	Water + Organism (µg/L)	0.041	n/a	n/a
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References	<p>ATSDR. (1997). Toxicological Profile for Chlorpyrifos. <a href="https://doi.org/http://dx.doi.org/10.1155/2013/286524">https://doi.org/http://dx.doi.org/10.1155/2013/286524</a></p> <p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p> <p>EPA. (2014). Priority Pollutant List. Retrieved from <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a></p>									

- EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <https://www.epa.gov/epcra/epcracerclaaa-ss112r-consolidated-list-lists-march-2015-version>
- EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from [https://ofmpub.epa.gov/apex/guideme\\_ext/guideme\\_ext/r/files/static/v3321/rfi/RY\\_2016\\_RFI.pdf](https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf)
- EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <https://comptox.epa.gov/dashboard>
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- NLM. (2017). PubChem Substance and Compound Databases. Retrieved November 1, 2017, from <https://pubchem.ncbi.nlm.nih.gov/>

# Cr

<p>Profile</p>	<p>Classification: Metal</p> <p>CASRN: 7440-47-3</p> <p>Molecular Formula: Cr</p> <p>IUPAC Name: Chromium</p> <p>Synonyms: none</p> <p><u>Source:</u> (EPA, 2017)</p> <p>Description</p> <p>Chromium occurs naturally in the environment as a metal ore in various oxidation states (but not as the elemental chromium). Chromium ranges in oxidation states from divalent (-II) to hexavalent (+VI); the trivalent and hexavalent states are the most predominant. Chromium is found as a steel-gray metal that is extracted from the earth via mining and other industrial processes.</p> <p>Chemical Characteristics</p> <table border="1"> <tr> <td>Molecular Weight (g/mol)</td><td>52</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>7.14 @ 20°C</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>86,670 @ 25°C</td></tr> <tr> <td>Boiling Point (°C)</td><td>2,642</td></tr> <tr> <td>Melting Point (°C)</td><td>1,900</td></tr> <tr> <td>Octanol-water partitioning coefficient (log K<sub>ow</sub>)</td><td>0.230</td></tr> <tr> <td>Octanol-air partitioning coefficient (log K<sub>oa</sub>)</td><td>0.229</td></tr> <tr> <td>Organic carbon-water partitioning coefficient (log K<sub>oc</sub>)</td><td>0.199</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td>4.24E<sup>-9</sup> @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td>0.025 @ 25°C</td></tr> </table> <p><u>Sources:</u> (ATSDR, 2012; EPA, 2018; SRC, 2013)</p> <p>Organic Solvents</p> <p>Insoluble in organic solvents and water.</p> <p><u>Sources:</u> (ATSDR, 2012; NLM, 2017)</p>	Molecular Weight (g/mol)	52	Density (g/cm <sup>3</sup> )	7.14 @ 20°C	Water Solubility (mg/L)	86,670 @ 25°C	Boiling Point (°C)	2,642	Melting Point (°C)	1,900	Octanol-water partitioning coefficient (log K <sub>ow</sub> )	0.230	Octanol-air partitioning coefficient (log K <sub>oa</sub> )	0.229	Organic carbon-water partitioning coefficient (log K <sub>oc</sub> )	0.199	Vapor Pressure (mmHg)	4.24E <sup>-9</sup> @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	0.025 @ 25°C
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<p>Sources</p>	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>Natural weathering of chromium-bearing rocks and soil</li> <li>Volcanic dust and gas flux</li> </ul> <p>Non-natural Sources &amp; Uses:</p> <ul style="list-style-type: none"> <li>Mines producing chromium (mostly Oregon)</li> <li>Reduction of chromite ore with carbon, aluminum, or silicon</li> <li>Production of sodium chromate and dichromate</li> <li>Leather tanning (sodium dichromate)</li> <li>Paint pigment (zinc and lead chromate)</li> <li>Ore and foundry sand</li> <li>Chromium chemicals</li> <li>Metallurgical industry (alloy cast irons, nonferrous alloys, stainless steel)</li> </ul>																				

	<ul style="list-style-type: none"> <li>• High temperature industrial furnace linings</li> <li>• Wood preservative (chromium VI)</li> <li>• Copy machine toners</li> <li>• Textiles</li> <li>• Pharmaceutical (including vitamins)</li> <li>• Magnetic tapes</li> </ul> <p><b>Releases to Air</b> Emissions of chromium are reported from production processes and consumptive use, including hazardous waste sites, fuel combustion (natural gas, oil, and coal), metal industries (chrome plating and steel production), cement producing plants, debris from asbestos brake linings, refuse incineration, sewage sludge, automotive catalytic converters, cooling towers with chromium chemicals. Natural sources are from volcanic dust and gas fluxes.</p> <p><b>Releases to Soil</b> Releases of chromium to soil are reported from production processes and consumptive use, including underground injection, disposal of coal/bottom fly ash from electrical utilities and other industries, solid wastes from metal manufacturing, and releases from hazardous waste sites and landfills.</p> <p><b>Releases to Water</b> Releases of chromium to surface waters are reported from production processes and consumptive use, primarily from industrial wastewater effluent. Other sources include metal manufacturing, sewage dumping, chemical manufacturing, smelting, refining of nonferrous metal, and releases from hazardous waste sites and landfills. Natural sources include atmospheric deposition and land erosion.</p> <p>Source: (ATSDR, 2012)</p>
Transport and Fate	<p><b>Transformation &amp; Degradation</b> Chromium is found in various states dependent on the conditions of environmental media and presence of other complex ions.</p> <ul style="list-style-type: none"> <li>• In air, chromium (VI) can be reduced to chromium (III) by the presence of other complex ions. Chromium (III) can be oxidized to chromium (VI) if manganese oxide is present in aerosols.</li> <li>• In water, chromium (VI) can be reduced to chromium (III) in the presence of suitable reducing agents (i.e., organic matter, hydrogen sulfide, sulfur, iron sulfide, ammonium, and nitrate). Reduction occurs favorably under acidic conditions and the type/amount of organic material. Chromium (III) can be oxidized to chromium (VI) in the presence of oxidizing agents (i.e., manganese oxide and pH ranges of 5-7 during chlorination). Chromium (VI) predominates under highly oxidizing conditions, in shallow aquifers. Chromium (III) predominates under reducing conditions, in deeper anaerobic groundwater.</li> <li>• In soil, chromium is predominantly chromium (III), which has low mobility (low solubility and reactivity). In deeper soils with anaerobic conditions, chromium (VI) can be reduced to chromium (III) by other complex ions present. In shallow soils with aerobic conditions, chromium (VI) can be reduced to chromium (III) by low pH conditions. Chromium (III) can be oxidized to chromium (VI) in soil by organic substances, oxygen, manganese dioxide, moisture, and high temperatures.</li> </ul>

	<p>Partitioning</p> <p>The transport and partitioning of chromium is dependent on the speciation complex and the environmental media.</p> <ul style="list-style-type: none"><li>• In air, chromium exists primarily in particulate form dependent on the particle size. Chromium particles can be transported long distances and undergo dry/wet atmospheric deposition. Chromium is mostly transported by windblown sea spray since it does not volatilize from water surfaces.</li><li>• In water, chromium can occur in both soluble and insoluble forms (a small percentage of both). Chromium (III) occurs primarily as suspended solids adsorbed onto clay materials, organics, or iron oxide in water. Chromium does not volatilize from water and most releases from water will deposit into sediment.</li><li>• In soil, chromium can form soluble complexes in low pH conditions. Organic matter is capable of converting soluble chromium (VI) to insoluble chromium (III). Chromium's mobility is dependent on the speciation form and soil properties (pH and redox potential). Chromium is present mostly as chromium (III) in soil, which has low solubility and reactivity, and thus low mobility. Chromium (VI) is relatively soluble and mobile. Chromium is the least mobile of metals in soils. Limited leaching of chromium in soil to groundwater occurs; however, soluble/unabsorbed chromium (VI) and chromium (III) complex are capable of leaching to groundwater (leachability increases with pH).</li></ul> <p>Bioaccumulation/Bioconcentration</p> <p>Bioavailability of chromium (III) to freshwater invertebrates decreases with additional humic acid (due to the availability of the free form of the metal). Chromium is not expected to biomagnify or bioconcentrate in aquatic food chains. Bioaccumulation of chromium from soil to plants is not likely. Biomagnification of chromium in terrestrial food chain is not likely.</p> <table><tr><th>Bioconcentration Factor</th><th>Bioaccumulation Factor</th></tr><tr><td>Chromium VI: 1</td><td>n/a</td></tr><tr><td>Chromium III and VI: 86 to 192</td><td></td></tr></table> <p><u>Note:</u> BCF reported for fish</p> <p><u>Source:</u> (ATSDR, 2012)</p>	Bioconcentration Factor	Bioaccumulation Factor	Chromium VI: 1	n/a	Chromium III and VI: 86 to 192				
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	<p>°C – degrees Celsius</p> <p>EPA – Environmental Protection Agency</p> <p>EPCRA – Environmental Planning and Community Right-to-Know Act</p> <p>g/cm<sup>3</sup> – grams per centimeter cubed</p> <p>IUPAC – International Union of Pure and Applied Chemistry</p> <p>L/kg – liters per kilogram</p> <p>log – log base 10 of K (i.e., 10<sup>K</sup>)</p> <p>mm Hg – millimeters mercury</p> <p>mol/L – moles per liter</p> <p>n/a – not available / not analyzed</p> <p>µg/liter – micrograms per liter</p>
References	<p>ATSDR. (2012). Toxicological Profile for Chromium. Retrieved from <a href="https://www.atsdr.cdc.gov/toxprofiles/index.asp#D">https://www.atsdr.cdc.gov/toxprofiles/index.asp#D</a></p> <p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p> <p>EPA. (2014). Priority Pollutant List. Retrieved from <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a></p> <p>EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <a href="https://www.epa.gov/epcra/epcracerclacaa-ss112r-consolidated-list-lists-march-2015-version">https://www.epa.gov/epcra/epcracerclacaa-ss112r-consolidated-list-lists-march-2015-version</a></p> <p>EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from <a href="https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf">https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf</a></p> <p>EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <a href="https://comptox.epa.gov/dashboard">https://comptox.epa.gov/dashboard</a></p> <p>EPA. (2018). Estimation Programs Interface Suite. Retrieved from <a href="https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface# citing">https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface# citing</a></p> <p>NLM. (2017). PubChem Substance and Compound Databases. Retrieved November 1, 2017, from <a href="https://pubchem.ncbi.nlm.nih.gov/">https://pubchem.ncbi.nlm.nih.gov/</a></p> <p>SRC. (2013). FatePointers Search Module, PhysProp. Retrieved December 1, 2017, from <a href="http://esc.srcinc.com/fatepointer/search.asp">http://esc.srcinc.com/fatepointer/search.asp</a></p>



Cu

<p>Profile</p>	<p>Classification: Metal</p> <p>CASRN: 7440-50-8</p> <p>Molecular Formula: Cu</p> <p>IUPAC Name: Copper</p> <p>Synonyms: none</p> <p>Source: (EPA, 2017)</p> <p>Description</p> <p>Copper occurs naturally in the environment as a metal ore in various oxidation states (I, II, and III). Copper exists as the element and as compounds (occurs naturally in many compounds). Copper is found as a red metal that is extracted from the earth via mining.</p> <p>Chemical Characteristics</p> <table border="1"> <tr> <td>Molecular Weight (g/mol)</td><td>64</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>n/a</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>720,800 @ 25°C</td></tr> <tr> <td>Boiling Point (°C)</td><td>2,595</td></tr> <tr> <td>Melting Point (°C)</td><td>1,083</td></tr> <tr> <td>Octanol-water partitioning coefficient (log K<sub>ow</sub>)</td><td>-0.570</td></tr> <tr> <td>Octanol-air partitioning coefficient (log K<sub>oa</sub>)</td><td>-0.571</td></tr> <tr> <td>Organic carbon-water partitioning coefficient (log K<sub>oc</sub>)</td><td>-0.495</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td>4.24x10<sup>-9</sup> @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm·m<sup>3</sup>/mol)</td><td>0.025 @ 25°C</td></tr> </table> <p>Source: (ATSDR, 2004; EPA, 2018; SRC, 2013)</p> <p>Organic Solvents</p> <p>Insoluble in organic solvents and water.</p> <p>Source: (ATSDR, 2004; NLM, 2017)</p>	Molecular Weight (g/mol)	64	Density (g/cm <sup>3</sup> )	n/a	Water Solubility (mg/L)	720,800 @ 25°C	Boiling Point (°C)	2,595	Melting Point (°C)	1,083	Octanol-water partitioning coefficient (log K <sub>ow</sub> )	-0.570	Octanol-air partitioning coefficient (log K <sub>oa</sub> )	-0.571	Organic carbon-water partitioning coefficient (log K <sub>oc</sub> )	-0.495	Vapor Pressure (mmHg)	4.24x10 <sup>-9</sup> @ 25°C	Henry's Law Constant (atm·m <sup>3</sup> /mol)	0.025 @ 25°C
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<p>Sources</p>	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>Natural weathering of copper-bearing rocks and soil</li> <li>Forest fires</li> <li>Volcanic explosions</li> <li>Biogenic processes</li> <li>Sea spray</li> </ul> <p>Non-natural Sources &amp; Uses:</p> <ul style="list-style-type: none"> <li>Mines producing copper</li> <li>Metals or alloys</li> <li>U.S. coins</li> <li>Manufacturing of copper sulfate, copper hydroxide, copper carbonate</li> <li>Plumbing and building wire</li> <li>Telecommunications, power utilities, manufacturing plant equipment</li> <li>Air condition</li> </ul>																				

	<ul style="list-style-type: none"> <li>• Automotive electrical</li> <li>• Business electronics</li> <li>• Industrial valves/fittings</li> <li>• Agricultural (fungicides, fertilizers)</li> <li>• Metal finishing</li> <li>• Wood preservation</li> <li>• Electroplating</li> <li>• Petroleum refining</li> <li>• Water treatment</li> <li>• Copper scrap</li> </ul> <p>Releases to Air Emissions of copper are reported from production processes and consumptive use, including nonferrous metal mining/production, waste incineration, industrial applications, coal/oil/gasoline combustion, smelters, and phosphate fertilizer manufacturing, automobile combustion, and hazardous waste sites. Natural sources include windblown dust, volcanic explosions, forest fires, biogenic processes, and sea spray.</p> <p>Releases to Soil Releases of copper to soil are reported from production processes and consumptive use, including mine tailings and milling, sludge from municipal wastewater treatment (industrial and municipal), electroplating waste, iron and steel producing wastes, discarded copper products, releases from hazardous waste sites, and leachates from landfills. Releases of copper to soil predominates releases to air and water.</p> <p>Releases to Water Releases of copper to surface waters are reported from production processes and consumptive use, primarily in particulate matter, including urban stormwater runoff (building siding and roofs, automobile emissions, plumbing corrosion), industrial wastewater effluent, domestic sewage effluent, mining and milling effluent, releases from hazardous waste sites, leachates from landfills, and agricultural runoff. Natural sources include atmospheric deposition and land erosion.</p> <p><u>Source:</u> (ATSDR, 2004)</p>
Transport and Fate	<p>Transformation &amp; Degradation Copper is found in various states dependent on the conditions of environmental media and presence of other complex ions.</p> <ul style="list-style-type: none"> <li>• In air, copper is believed to exist as oxides. Sulfatization may occur when SO<sub>x</sub> gases are present in certain amounts. Copper (II) can be reduced to copper (I) in the presence of sulfite in fog, dependent on pH.</li> <li>• In water, copper is mostly in the copper (II) state and forms complexes with inorganic/organic ligands (including ammonia, chloride, and humic acids). Copper (II) can be reduced to copper (I) in water as a result of numerous processes, including by photochemical reducing agents. Organic matter is the most important complexing agent for copper. Certain cuprous compounds are mostly insoluble in water. Copper concentrations in water are dependent on pH, oxidation-reduction potential of water, and presence of competing ions, salts, and anions of insoluble complexing agents. Copper can be dissolved or associated with particulate matter and adsorption increases with pH</li> </ul>

(hardness or salinity also has an affect).

- In soil, copper is adsorbed by complexation and transformation. Copper is bound mostly to organic and inorganic matter in soil and to mineral matter and organic matter in sediment. Copper can also be released into pore water within the soil/sediment. Adsorption to soil is associated with pH and other soil conditions. At pH >5, adsorption is more significant and at pH<5, copper remains in pore water and is more mobile in soil. In anaerobic soils, cupric salts (copper (II)) can be reduced to cuprous salts (copper (I)).

## Partitioning

The transport and partitioning of copper is dependent on the speciation complex and the environmental media.

- In air, copper exists primarily in particulate matter or adsorbed to particulate matter, dependent on the particle size. Copper particles can be transported long distances and undergo dry/wet atmospheric deposition depending on the particle size and location.
- In water, copper exists primarily as particulate matter and settles out as it adsorbs readily to sediment, organic matter (high content), clay, hydrous iron and manganese oxides. Copper's adsorptive affinity increases with pH.
- In soil, copper adsorbs readily in the upper surface layers to organic matter, carbonate/clay minerals, or hydrous iron and manganese oxides. Adsorption is primarily affected by metal concentrations, pH, soil strength, organic matter, and microorganisms. The mineral content of soil determines copper's adsorption capacity when organic matter content is low. Copper's ability to leach in soil is dependent on the soil type and properties (more leaching in sandy soils with low pH). Copper leaching increases with low pH waters (i.e., acid rain). Copper remains on the soil surface when applied as a liquid.

## Bioaccumulation/Bioconcentration

The bioconcentration potential of copper in fish is low. There is little biomagnification of copper in the aquatic and terrestrial food chain.

Bioconcentration Factor	Bioaccumulation Factor
Fish: 10 to 667	n/a
Mollusks: 30,000 to 2.1E <sup>7</sup>	

Note: BCF reported for fish

Source: (ATSDR, 2004)

## Water Quality Regulations

### Oregon Water Quality Standards

Aquatic Life Water Quality Criteria	Aquatic Life Water Quality Guidance Values	Human Health Water Quality Criteria
Freshwater, Chronic (µg/L)	Freshwater, Chronic (µg/L)	Water + Organism (µg/L)
function of concentration of ions, alkalinity, organic carbon, pH, and temperature	n/a	1,300

Source: (DEQ, 2017)

	<p>Priority Pollutant (EPA's Clean Water Act): Yes</p> <p>TRI-Listed Pollutant (EPA's EPCRA Section 313): Yes</p> <p>Reportable Pollutant (EPA's CERCLA's Section 304): Yes</p> <p>Source: (EPA, 2014, 2015, 2016)</p>
Abbreviations / Acronyms	<p>atm·m<sup>3</sup>/mol – atmosphere-cubic meters per mole</p> <p>CASRN – Chemical Abstract Registry Number</p> <p>CERCLA – Comprehensive Environmental Response, Compensation and Liability Act</p> <p>°C – degrees Celsius</p> <p>EPA – Environmental Protection Agency</p> <p>EPCRA – Environmental Planning and Community Right-to-Know Act</p> <p>g/cm<sup>3</sup> – grams per centimeter cubed</p> <p>IUPAC – International Union of Pure and Applied Chemistry</p> <p>L/kg – liters per kilogram</p> <p>log – log base 10 of K (i.e., 10<sup>K</sup>)</p> <p>mm Hg – millimeters mercury</p> <p>mol/L – moles per liter</p> <p>n/a – not available / not analyzed</p> <p>µg/liter – micrograms per liter</p>
References	<p>ATSDR. (2004). Toxicological Profile for Copper.  <a href="https://doi.org/doi:10.1201/9781420061888_ch106">https://doi.org/doi:10.1201/9781420061888_ch106</a></p> <p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from  <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p> <p>EPA. (2014). Priority Pollutant List. Retrieved from  <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a></p> <p>EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <a href="https://www.epa.gov/epcra/epcracerclacaa-ss112r-consolidated-list-lists-march-2015-version">https://www.epa.gov/epcra/epcracerclacaa-ss112r-consolidated-list-lists-march-2015-version</a></p> <p>EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from <a href="https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf">https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf</a></p> <p>EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <a href="https://comptox.epa.gov/dashboard">https://comptox.epa.gov/dashboard</a></p> <p>EPA. (2018). Estimation Programs Interface Suite. Retrieved from <a href="https://www.epa.gov/tsca-">https://www.epa.gov/tsca-</a></p>

screening-tools/epi-suitetm-estimation-program-interface#citing

NLM. (2017). PubChem Substance and Compound Databases. Retrieved November 1, 2017, from <https://pubchem.ncbi.nlm.nih.gov/>

SRC. (2013). FatePointers Search Module, PhysProp. Retrieved December 1, 2017, from <http://esc.srcinc.com/fatepointer/search.asp>

<p>Profile</p>	<p>Classification: Volatile Organic Compound</p> <p>CASRN: 57-12-5</p> <p>Molecular Formula: CN</p> <p>IUPAC Name: Cyanide</p> <p>Synonyms: cyanide ion, cyanide anion</p> <p>Source: (EPA, 2017) (NLM, 2017)</p> <p>Description</p> <p>Cyanide is a colorless, inorganic nonmetal anion that is both naturally occurring and man-made. Cyanide is both a chemical group and a compound. Cyanide compounds contain a cyanide group, such as hydrogen cyanide and cyanide salts (formed from sodium and potassium cyanide). Cyanide is used for numerous industrial processes. Cyanide can bind with other chemicals and become a volatile organic compound, for example: hydrogen cyanide and acetonitrile (ATSDR, 2006).</p> <p>Chemical Characteristics</p> <table border="1"> <tr> <td>Molecular Weight (g/mol)</td><td>27</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>0.695 @ 25°C</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>95,400 @ 25°C</td></tr> <tr> <td>Boiling Point (°C)</td><td>26</td></tr> <tr> <td>Melting Point (°C)</td><td>-13</td></tr> <tr> <td>Octanol-water partitioning coefficient (log K<sub>ow</sub>)</td><td>0.660</td></tr> <tr> <td>Octanol-air partitioning coefficient (log K<sub>oa</sub>)</td><td>0.437</td></tr> <tr> <td>Soil organic carbon-partitioning coefficient (log K<sub>oc</sub>)</td><td>0.936</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td>630 @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td>0.0510 @ 25°C</td></tr> </table> <p>Source: (ATSDR, 2006; EPA, 2018; SRC, 2013)</p> <p>Organic Solvents</p> <p>Soluble in ethanol and ether (hydrogen cyanide), slightly soluble in ethanol and formamide (sodium cyanide), slightly soluble in ethanol and methanol (potassium cyanide)</p> <p>Source: (ATSDR, 2006)</p>	Molecular Weight (g/mol)	27	Density (g/cm <sup>3</sup> )	0.695 @ 25°C	Water Solubility (mg/L)	95,400 @ 25°C	Boiling Point (°C)	26	Melting Point (°C)	-13	Octanol-water partitioning coefficient (log K <sub>ow</sub> )	0.660	Octanol-air partitioning coefficient (log K <sub>oa</sub> )	0.437	Soil organic carbon-partitioning coefficient (log K <sub>oc</sub> )	0.936	Vapor Pressure (mmHg)	630 @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	0.0510 @ 25°C
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<p>Sources</p>	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>Certain plant foods (almonds, millet sprouts, lima beans, soy, spinach, bamboo shoots, cassava roots)</li> <li>Certain bacteria, fungi, and algae</li> </ul> <p>Non-natural Sources &amp; Uses:</p> <ul style="list-style-type: none"> <li>Insecticides/fumigants</li> <li>Extraction of gold/silver ores (i.e., metals leaching)</li> <li>Metal cleaning and electroplating</li> <li>Dye/plastics/nylon manufacturing</li> <li>Reagents in analytical chemistry</li> </ul>																				



	<p><b>Releases to Air</b> Emissions of cyanide to the atmosphere are reported from vehicle exhaust, manufacturing of methyl methacrylate/acrylonitrile/hydrogen cyanide, iron and steel production, metals mining extractions, coal combustion, petroleum refineries, oil shale retorting processes, municipal solid waste incineration, combustion of nitrogen-containing plastics, cigarette smoke, volatilization from cyanide in landfills, and pesticide applications.</p> <p><b>Releases to Soil</b> Releases of cyanide to soil are landfill leachates and vehicle road runoff (cyanide salts), and industrial facility releases. Natural sources also release cyanide to soil.</p> <p><b>Releases to Water</b> Releases of cyanide to water are reported from municipal wastewater treatment facilities, iron/steel production, organic chemical industries, wastewaters from cyanide manufacturing, and underground injection, metals mining extraction tailing ponds (primarily gold), landfill leachate, hazardous waste disposal sites, agricultural runoff, road runoff (cyanide salts), and atmospheric deposition</p> <p><u>Source:</u> (ATSDR, 2006)</p>
<p><b>Transport and Fate</b></p>	<p><b>Transformation &amp; Degradation</b> Cyanide degrades and transforms to various different chemicals depending on its original compound and the environmental media (air, water, soil/sediment).</p> <ul style="list-style-type: none"> <li>• In the atmosphere, hydrogen cyanide is very resistant to photolysis (normal sunlight). Cyanide reactions in air are predominantly with photochemically-generated hydroxyl radicals.</li> <li>• In water, cyanide undergoes oxidation, hydrolysis, and photolysis. Cyanide also biodegrades in water by microorganisms.</li> <li>• In soil/sediment, cyanides do not undergo oxidation-reduction reactions but may undergo complexation reactions with metal ions. Cyanide degrades under aerobic conditions.</li> </ul> <p><b>Partitioning</b> Cyanide partitions primarily to the atmosphere and can revolatilize after deposition; it is moderately soluble in water and highly mobile in soil.</p> <ul style="list-style-type: none"> <li>• In air, cyanide is mostly found in the lower altitudes of the atmosphere and has the potential to be transported long distances. Cyanide particles are capable of being removed via wet and dry deposition.</li> <li>• In water, cyanide volatilizes rapidly and is the most significant process. Other cyanide salts that are more water soluble are removed by sedimentation and biodegradation. Cyanide is expected to persist in groundwater due to limited volatilization underground.</li> <li>• In soil, cyanides sorb to clays, biological solids, and sediments. However, hydrogen cyanide and alkali metal cyanides do not sorb strongly to sediments or suspended solids due to their higher water solubility. Sorption increases with decreasing pH and increasing iron oxide, clay, and organic material contents. Sorption is insignificant compared to volatilization and biodegradation.</li> </ul>

	<p>Bioaccumulation/Bioconcentration</p> <p>Metal cyanides and hydrogen cyanide do not bioconcentrate in aquatic organisms. Certain metal cyanide complexes can bioaccumulate. Cyanide does not biomagnify in aquatic and terrestrial plants and animals and therefore, bioaccumulation of cyanide in the food web is not expected.</p> <p><u>Source:</u> (ATSDR, 2014)</p>									
Water Quality Regulations	<p>Oregon Water Quality Standards</p> <table><tr><th>Aquatic Life Water Quality Criteria</th><th>Aquatic Life Water Quality Guidance Values</th><th>Human Health Water Quality Criteria</th></tr><tr><th>Freshwater, Chronic (µg/L)</th><th>Freshwater, Chronic (µg/L)</th><th>Water + Organism (µg/L)</th></tr><tr><td>5.2</td><td>n/a</td><td>130</td></tr></table> <p><u>Source:</u> (DEQ, 2017)</p> <p>Priority Pollutant (EPA's Clean Water Act): Yes TRI-Listed Pollutant (EPA's EPCRA Section 313): Yes Reportable Pollutant (EPA's CERCLA's Section 304): Yes</p> <p><u>Sources:</u> (EPA, 2014, 2015, 2016)</p>	Aquatic Life Water Quality Criteria	Aquatic Life Water Quality Guidance Values	Human Health Water Quality Criteria	Freshwater, Chronic (µg/L)	Freshwater, Chronic (µg/L)	Water + Organism (µg/L)	5.2	n/a	130
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	<p><a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a></p> <p>EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <a href="https://www.epa.gov/epcra/epcracerclaaa-ss112r-consolidated-list-lists-march-2015-version">https://www.epa.gov/epcra/epcracerclaaa-ss112r-consolidated-list-lists-march-2015-version</a></p> <p>EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from <a href="https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf">https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf</a></p> <p>EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <a href="https://comptox.epa.gov/dashboard">https://comptox.epa.gov/dashboard</a></p> <p>EPA. (2018). Estimation Programs Interface Suite. Retrieved from <a href="https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface#cite">https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface#cite</a></p> <p>NLM. (2017). PubChem Substance and Compound Databases. Retrieved November 1, 2017, from <a href="https://pubchem.ncbi.nlm.nih.gov/">https://pubchem.ncbi.nlm.nih.gov/</a></p> <p>SRC. (2013). FatePointers Search Module, PhysProp. Retrieved December 1, 2017, from <a href="http://esc.srcinc.com/fatepointer/search.asp">http://esc.srcinc.com/fatepointer/search.asp</a></p>
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## Profile

Classification: Organochlorine Insecticide

CASRN:

p,p-DDE: 72-55-9

p,p-DDT: 50-29-3

Molecular Formula:

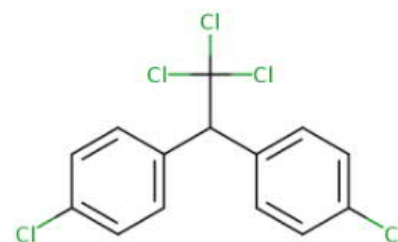
p,p-DDE:  $C_{14}H_8Cl_4$

p,p-DDT:  $C_{14}H_9Cl_5$

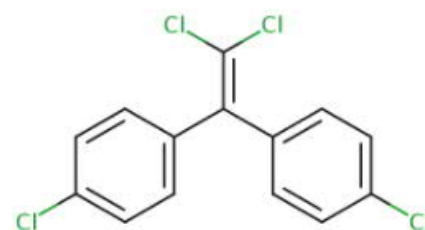
IUPAC Name:

DDE: 1-chloro-4-[2,2-dichloro-1-(4-chlorophenyl)ethenyl]benzene

DDT: 1-chloro-4-[2,2,2-trichloro-1-(4-chlorophenyl)ethyl]benzene



p,p-DDT



p,p-DDE

Synonyms:

p,p-DDE: dichlorodiphenyldichloroethylene; DDT dehydrochloride; 4,4-DDE

p,p-DDT: clofenotane; chlorophenothane; dichlorodiphenyltrichloroethane; 4,4-DDT

Sources: (ATSDR, 2002; EPA, 2017)

## Description

p,p-DDE and p,p-DDT are isomers of DDE and DDT, respectively. DDT is referred to the collection of all forms of DDT, DDE, and DDE (i.e., the sum of DDT). DDT is a pesticide that exists as a white amorphous powder (solid) and was used from 1939 until it was banned in 1973 in the U.S.

Technical grade DDT consists of up to 14 chemical compounds but is a mixture of three forms: p,p-DDT; o,p-DDT; and o,o-DDT. DDT may also contain DDE and DDD as contaminants (the break down products).

## Chemical Characteristics

Toxic Pollutant Isomer (CASRN)	p,p-DDE (72-55-9)	p,p-DDT (50-29-3)
Molecular Weight (g/mol)	318	354
Density (g/cm <sup>3</sup> )	1.43 @ 25°C	1.48
Water Solubility (mg/L)	0.120 @ 25°C	0.0025 @ 25°C
Boiling Point (°C)	336	260
Melting Point (°C)	89	109
Octanol-water coefficient (log $K_{ow}$ )	6.51	6.91
Octanol-air coefficient (log $K_{oa}$ )	9.18	9.31
Organic carbon-water coefficient (log $K_{oc}$ )	5.65	6.00
Vapor Pressure (mmHg)	$6.00 \times 10^{-6}$ @ 25°C	$1.60 \times 10^{-7}$ @ 25°C
Henry's Law Constant (atm-m <sup>3</sup> /mol)	$2.10 \times 10^{-5}$ @ 25°C	$8.30 \times 10^{-6}$ @ 25°C

Source: (ATSDR, 2002; EPA, 2018; SRC, 2013)

	<p>Organic Solvents</p> <p>p,p-DDE is soluble in water (at 0.12 mg/L, 25°C), lipids and most organic solvents. p,p-DDT is soluble in water (at 0.025 mg/L, 25°C), slightly soluble in ethanol, and very soluble in ethyl ether and acetone.</p> <p>Source: (ATSDR, 2002)</p>
Sources	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>None</li> </ul> <p>Non-natural Sources/Uses:</p> <ul style="list-style-type: none"> <li>Manufacturing/production of DDT by condensing chloral hydrate with chlorobenzene in concentrated sulfuric acid.</li> <li>Manufacturing/production of p,p-DDE by condensing dichloroacetaldehyde with chlorobenzene.</li> <li>Insecticide (p,p-DDT and p,p-DDE) on crops (deciduous fruit, cotton, peanuts, and soy), with peak use during WWII for controlling insect-transmitted diseases.</li> <li>Degradation products (DDE and DDD) formed by dehydrohalogenation of DDT.</li> </ul> <p>Releases to Air</p> <p>Emissions of DDT to the atmosphere are reported from manufacturing facilities (historical), agricultural and vector control spray applications (historical), and the subsequent volatilization and wind suspension (from historical releases).</p> <p>Releases to Soil</p> <p>Releases of DDT to soil are reported from manufacturing facilities (historical), direct soil application of agricultural and vector control spray (historical), releases from storage/disposal, and atmospheric deposition. DDT is also reported at contaminated hazardous waste sites.</p> <p>Releases to Water</p> <p>Releases of DDT to surface waters and groundwater are reported from manufacturing facilities (no longer occurring), agricultural and vector control spray drift applications (historical), atmospheric deposition, runoff/erosion of contaminated soils (historical direct applications), and contaminated sediment. DDT is also reported from contaminated hazardous waste sites.</p> <p>Source: (ATSDR, 2002)</p>
Transport and Fate	<p>Transformation &amp; Degradation</p> <p>DDT degrades into DDE and DDD.</p> <ul style="list-style-type: none"> <li>In the atmosphere, DDT is adsorbed to particulate matter (50%) and also exists in the vapor phase (50%). In the vapor phase, DDT reacts with photochemically produced hydroxyl radicals and by direct photolysis. When adsorbed on particulate matter, DDT is not expected to undergo rapid photooxidation, therefore, subject to long-range transport.</li> <li>In water, DDT may be transformed by photodegradation and biodegradation. Photolysis primarily occurs in surface water and is dependent on clarity. For DDT and DD, direct photolysis is slow in aquatic systems and for DDE, direct photolysis varies as a function of photoperiod and brightness. DDE also undergoes photoisomerization in sunlight. DDT undergoes hydrolysis by a base-catalyzed reaction, forming DDE. Hydrolysis of DDE is not significant.</li> </ul>

- In soil, DDT degrades via volatilization and chemical transformation (abiotic and biotic processes). DDT is transported and can transform via harvest (i.e., plants absorbing the residue) and water runoff. DDT and DDE can undergo photooxidation on soil surfaces and when adsorbed to sediment. UV radiation can mineralize DDT to DDE. DDT degradation to DDE is enhanced by increasing sunlight.

Biodegradation can occur under aerobic and anaerobic conditions, due to the presence of soil microorganism populations and soil conditions (including organic matter content). Soils with a low metal content degrade DDT to DDE slower than soils with a high metal content (Al, Ba, Cd, Co, Cr, Fe, and K). DDE is often resistant to biodegradation under aerobic and anaerobic conditions. Degradation (i.e., half-life) initially in soil of DDT is rapid, and then increases due to volatilization, followed by biodegradation (DDT migrates into soil particles and becomes unavailable). Degradation of p,p-DDE is at a slower rate than p,p-DDT. Degradation of DDT in tropical climates is more pronounced than in temperate climates due to higher temperatures causing volatilization.

## Partitioning

DDT is extremely persistent in soil. p,p-DDT and p,p-DDE sorb strongly to soil and are only slightly soluble in water, but volatilization from soil surfaces and water account for considerable losses.

- In the atmosphere, DDT undergoes long-range transport referred to as "global distillation" from warm sources areas to cold polar regions and can undergo atmospheric deposition.
- In water, p,p-DDE and p,p-DDT sorb to suspended solids in the water column and sediment, and are transported in surface water runoff via bound particulate matter (dependent on the agricultural practice [i.e., irrigation practices resulting in sediment runoff]). Sediment is the sink for DDT in water. DDT is present in the dissolved and particulate phase in water. Volatilization from surface waters is reported (faster in seawater than freshwater).
- In soil, DDT binds strongly to soil and would remain in the surface layers thereby, not leaching into groundwater. DDT can absorb to free-moving dissolved organic matter in the soil solution, which facilitates transport. DDT can volatilize from soil surfaces, enhanced by temperature, sunlight, and flooding.

## Bioaccumulation/Bioconcentration

DDT exhibits significantly high bioconcentration and biomagnification in aquatic organisms, as it is highly lipid soluble. Bioconcentration increases with increasing trophic levels in the aquatic environment. Biomagnification increases with increased DDT concentrations in higher trophic organisms. DDT, DDE, and DDD are bioavailable to plants, although sorbing strongly to soil, due to sorption of volatilized residues from surface-treated soil.

Toxic Pollutant	Bioconcentration Factor	Bioaccumulation Factor
p,p-DDE	n/a	n/a
p,p-DDT	12,000 to 100,000	n/a

Note: BCF reported for fish

Source: (ATSDR, 2002)

Water Quality Regulations	Oregon Water Quality Standards			
		Aquatic Life Water Quality Criteria	Aquatic Life Water Quality Guidance Values	Human Health Water Quality Criteria
	Toxic Pollutant	Freshwater, Chronic (µg/L)	Freshwater, Chronic (µg/L)	Water + Organism (µg/L)
	p,p-DDE	n/a	n/a	0.000022
	p,p-DDT	0.001	n/a	0.000022
	Source: (DEQ, 2017)			
	Priority Pollutant (EPA's Clean Water Act): Yes TRI-Listed Pollutant (EPA's EPCRA Section 313): No Reportable Pollutant (EPA's CERCLA's Section 304): Yes			
	Sources: (EPA, 2014, 2015, 2016)			
Abbreviations / Acronyms	atm-m <sup>3</sup> /mol – atmosphere-cubic meters per mole CASRN – Chemical Abstract Registry Number °C – degrees Celsius CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act EPA – Environmental Protection Agency EPCRA – Environmental Planning and Community Right-to-Know Act g/cm <sup>3</sup> – grams per centimeter cubed IUPAC – International Union of Pure and Applied Chemistry L/kg – liters per kilogram log – log base 10 of K (i.e., 10 <sup>K</sup> ) mmHg – millimeters mercury mol/L – moles per liter n/a – not available / not analyzed µg/liter – micrograms per liter			
References	ATSDR. (2002). Toxicological Profile for DDT, DDE, and DDD. <a href="https://doi.org/CAS#: DDT 50-29-3; DDE 72-55-9; DDD 72-54-8">https://doi.org/CAS#: DDT 50-29-3; DDE 72-55-9; DDD 72-54-8</a> DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a> EPA. (2014). Priority Polluant List. Retrieved from <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a> EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved			

from <https://www.epa.gov/epcra/epcracerclacaa-ss112r-consolidated-list-lists-march-2015-version>

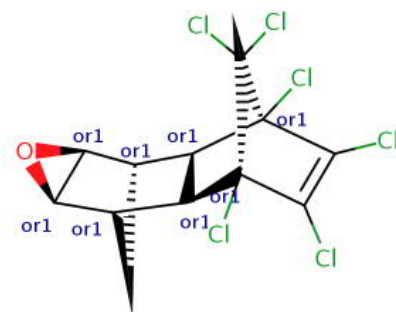
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EPA. (2018). Estimation Programs Interface Suite. Retrieved from <https://www.epa.gov/tsca-screening-tools/epi-suite-tm-estimation-program-interface# citing>

SRC. (2013). FatePointers Search Module, PhysProp. Retrieved December 1, 2017, from <http://esc.srcinc.com/fatepointer/search.asp>

<p>Profile</p>	<p>Classification: Organochlorine Insecticide</p> <p>CASRN: 60-57-1</p> <p>Molecular Formula: <math>C_{12}H_8Cl_6O</math></p> <p>IUPAC Name: 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4<math>\alpha</math>,5,6,7,8,8<math>\alpha</math>-octahydro-1,4-endo,exo-5,8-dimethanonaphthalene</p> <p>Synonyms: HEOD</p> <p>Source: (ATSDR, 2002; EPA, 2017)</p> <p>Description</p> <p>Dieldrin, the breakdown product of Aldrin, is a man-made chemical, existing as a tan powder, known as a chlorinated cyclodiene (derived from hexachlorocyclopentadiene), and was used as an insecticide from 1948 to the 1970s (on crops) and from 1972 to 1987 (on termites), along with Aldrin. Dieldrin (along with Aldrin) was banned in 1974 and completely cancelled as a registered pesticide in 1989.</p> <p>Chemical Characteristics</p> <table border="1"> <tbody> <tr> <td>Molecular Weight (g/mol)</td><td>381</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>1.85 @ 25°C</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>0.110 @ 25°C</td></tr> <tr> <td>Boiling Point (°C)</td><td>330</td></tr> <tr> <td>Melting Point (°C)</td><td>177</td></tr> <tr> <td>Octanol-water partitioning coefficient (log <math>K_{ow}</math>)</td><td>6.20</td></tr> <tr> <td>Octanol-air partitioning coefficient (log <math>K_{oa}</math>)</td><td>8.90</td></tr> <tr> <td>Soil organic carbon-water partitioning coefficient (log <math>K_{oc}</math>)</td><td>3.82</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td><math>5.89 \times 10^{-6}</math> @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm·m<sup>3</sup>/mol)</td><td><math>5.20 \times 10^{-6}</math> @ 25°C</td></tr> </tbody> </table> <p>Source: (ATSDR, 2002; EPA, 2018; SRC, 2013)</p> <p>Organic Solvents</p> <p>Moderately soluble in common organic solvents except aliphatic petroleum solvents and methyl alcohol.</p> <p>Source: (ATSDR, 2002)</p>	Molecular Weight (g/mol)	381	Density (g/cm <sup>3</sup> )	1.85 @ 25°C	Water Solubility (mg/L)	0.110 @ 25°C	Boiling Point (°C)	330	Melting Point (°C)	177	Octanol-water partitioning coefficient (log $K_{ow}$ )	6.20	Octanol-air partitioning coefficient (log $K_{oa}$ )	8.90	Soil organic carbon-water partitioning coefficient (log $K_{oc}$ )	3.82	Vapor Pressure (mmHg)	$5.89 \times 10^{-6}$ @ 25°C	Henry's Law Constant (atm·m <sup>3</sup> /mol)	$5.20 \times 10^{-6}$ @ 25°C
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<p>Sources</p>	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>None</li> <li>Breakdown (i.e., degradation) product of Aldrin</li> </ul> <p>Non-natural Sources &amp; Uses:</p> <ul style="list-style-type: none"> <li>Manufacturing/production by the epoxidation of aldrin (legacy)</li> <li>Insecticide on crops (citrus, corn), timber, termites (around plastic and rubber coverings around electrical/telecommunication cables and plywood/building boards) (legacy)</li> </ul> <p>Releases to Air</p> <p>Emissions of dieldrin to the atmosphere are reported from hazardous waste sites emissions, and</p>																				



	<p>previously treated soil/crops emissions (i.e., atmospheric dispersal).</p> <p><b>Releases to Soil</b> Releases of dieldrin to soil are reported from contaminated hazardous waste sites, improper disposal from old dieldrin (and parent compound aldrin) inventory, and wet/dry atmospheric deposition.</p> <p><b>Releases to Water</b> Releases of dieldrin to surface waters and groundwater are reported from contaminated hazardous waste sites and stormwater runoff from cropland.</p> <p><u>Source:</u> (ATSDR, 2002)</p>				
Transport and Fate	<p><b>Transformation &amp; Degradation</b> Dieldrin is a breakdown product of Aldrin. Dieldrin is more persistent in the environment: it is more resistant to biotransformation and abiotic degradation than aldrin.</p> <ul style="list-style-type: none"> <li>• In the atmosphere, the vapor phase of dieldrin can photodegrade to photodieldrin (a stereoisomer of dieldrin) via reaction with photochemically-produced hydroxy radicals. The particulate phase of dieldrin in the atmosphere will not participate in hydroxyl radical reactions. Dieldrin does not undergo significant degradation in biologically active wastewater sludge or by sewage sludge microorganism under anaerobic conditions.</li> <li>• In water, Dieldrin undergoes minor degradation to photodieldrin by marine algae. Aldrin does not undergo significant degradation.</li> <li>• In soil, dieldrin is persistent to various soil moistures but can undergo degradation by ultraviolet light to form photodieldrin.</li> </ul> <p><b>Partitioning</b></p> <ul style="list-style-type: none"> <li>• In air, Dieldrin will exist in both vapor and particulate phases in the atmosphere and can undergo atmospheric transport and dry/wet atmospheric deposition.</li> <li>• In water, dieldrin is expected to volatilize, but may be attenuated by the presence of adsorption to suspended solids and sediment in the water column. Movement of dieldrin in water borne sediment is expected from treated soil. Dieldrin is not present in groundwater.</li> <li>• In soil, dieldrin is expected to be immobile (due to its high soil adsorption ability); however, mobility can increase in soil with the presence of organic solvents (by increasing water solubility). Volatilization from soil is expected to occur, but slowly (due to its lower vapor pressure and strong sorption to soil); volatilization from soil is slow (slower compared to Aldrin); dieldrin is resistant to soil leaching.</li> </ul> <p><b>Bioaccumulation/Bioconcentration</b> Dieldrin has a high potential for bioaccumulation and bioconcentration in terrestrial and aquatic organisms and terrestrial ecosystems.</p> <table border="1"> <thead> <tr> <th>Bioconcentration Factor</th><th>Bioaccumulation Factor</th></tr> </thead> <tbody> <tr> <td>4,860 to 14,500</td><td>1</td></tr> </tbody> </table> <p><u>Note:</u> BCF and BAF values reported for fish</p> <p><u>Source:</u> (ATSDR, 2002)</p>	Bioconcentration Factor	Bioaccumulation Factor	4,860 to 14,500	1
Bioconcentration Factor	Bioaccumulation Factor				
4,860 to 14,500	1				



Water Quality Regulations	Oregon Water Quality Standards		
	Aquatic Life Water Quality Criteria	Aquatic Life Water Quality Guidance Values	Human Health Water Quality Criteria
	Freshwater, Chronic (µg/L)	Freshwater, Chronic (µg/L)	Water + Organism (µg/L)
	0.056	n/a	0.0000053
	<u>Source:</u> (DEQ, 2017)		
	Priority Pollutant (EPA's Clean Water Act): Yes TRI-Listed Pollutant (EPA's EPCRA Section 313): No Reportable Pollutant (EPA's CERCLA's Section 304): Yes		
	<u>Source:</u> (EPA, 2014, 2015, 2016)		
Abbreviations / Acronyms	atm-m <sup>3</sup> /mol – atmosphere-cubic meters per mole CASRN – Chemical Abstract Registry Number CERCLA – Comprehensive Environmental Response, Compensation and Liability Act °C – degrees Celsius EPA – Environmental Protection Agency EPCRA – Environmental Planning and Community Right-to-Know Act g/cm <sup>3</sup> – grams per centimeter cubed IUPAC – International Union of Pure and Applied Chemistry L/kg – liters per kilogram log – log base 10 of K (i.e., 10 <sup>K</sup> ) mmHg – millimeters mercury mol/L – moles per liter n/a – not available / not analyzed µg/liter – micrograms per liter		
References	ATSDR. (2002). Toxicological Profile for Aldrin / Dieldrin. Retrieved from <a href="https://www.atsdr.cdc.gov/toxprofiles/index.asp#D">https://www.atsdr.cdc.gov/toxprofiles/index.asp#D</a> DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a> EPA. (2014). Priority Pollutant List. Retrieved from <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a> EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <a href="https://www.epa.gov/epcra/epcracerclaaa-ss112r-consolidated-list-lists-march-2015-version">https://www.epa.gov/epcra/epcracerclaaa-ss112r-consolidated-list-lists-march-2015-version</a>		

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|  | <p>EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from <a href="https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf">https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf</a></p> <p>EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <a href="https://comptox.epa.gov/dashboard">https://comptox.epa.gov/dashboard</a></p> <p>EPA. (2018). Estimation Programs Interface Suite. Retrieved from <a href="https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface#cite">https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface#cite</a></p> <p>SRC. (2013). FatePointers Search Module, PhysProp. Retrieved December 1, 2017, from <a href="http://esc.srcinc.com/fatepointer/search.asp">http://esc.srcinc.com/fatepointer/search.asp</a></p> |
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## Profile

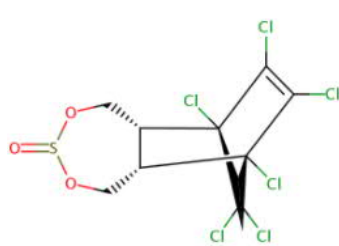
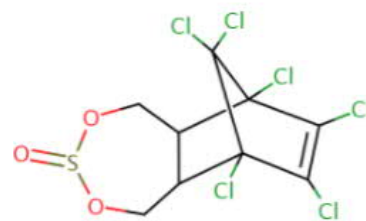
Classification: Organochlorine Insecticide

CASRN: 115-29-7

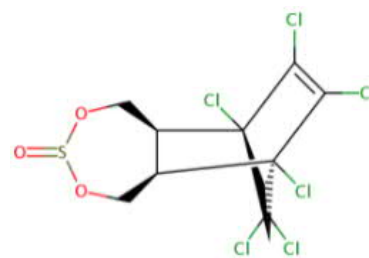
Molecular Formula:  $C_9H_6Cl_6O_3S$

IUPAC Name: 6,7,8,9,10,10-Hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepine-3-oxide

Synonyms: Endosulfan I; alpha-endosulfan; Endosulfan II; beta-endosulfan



Endosulfan I (alpha)



Endosulfan II (beta)

Sources: (ATSDR, 2015; EPA, 2017)

## Description

Endosulfan is a man-made pesticide that exists as a cream to brown (beige) crystalline solid, existing as a mixture of two different forms: alpha (70%) and beta (30%). Its use began in 1954 but is restricted to certain crops (by a "certified pesticide applicator") and was scheduled for cancellation (2012-2016). Four registered products with endosulfan existed in 2012 and complete phase-out of endosulfan occurred by 2016.

## Chemical Characteristics

Toxic Pollutant Isomer (CASRN)	Endosulfan (115-29-7)	Endosulfan I (959-98-8)	Endosulfan II (33213-65-9)
Molecular Weight (g/mol)	407	407	407
Density (g/cm <sup>3</sup> )	1.88 @ 25°C	1.88 @ 25°C	1.88 @ 25°C
Water Solubility (mg/L)	0.530 @ 25°C	0.510 @ 25°C	0.450 @ 25°C
Boiling Point (°C)	106	106	106
Melting Point (°C)	106	106	106
Octanol-water coefficient (log K <sub>ow</sub> )	3.83	3.83	4.13
Octanol-air coefficient (log K <sub>oa</sub> )	10.6	n/a	n/a
Soil organic carbon-water coefficient (log K <sub>oc</sub> )	3.21	7.09E <sup>-6</sup>	3.91E <sup>-7</sup>
Vapor Pressure (mmHg)	1.73x10 <sup>-7</sup> @ 25°C	3.00x10 <sup>-6</sup> @ 25°C	6.00x10 <sup>-7</sup> @ 25°C
Henry's Law Constant (atm-m <sup>3</sup> /mol)	6.50x10 <sup>-5</sup> @ 25°C	7.09x10 <sup>-6</sup> @ 25°C	3.91x10 <sup>-6</sup> @ 25°C

Source: (ATSDR, 2015; EPA, 2018; SRC, 2013)

## Organic Solvents

Soluble in dichloromethane, ethanol, ethyl acetate, hexane, toluene, acetone, benzene, carbon tetrachloride, chloroform, ethanol, kerosene, methanol, and xylene (at varying concentrations).

Source: (ATSDR, 2015; EPA, 2016a)

Sources	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>• None</li> </ul> <p>Non-natural Sources/Uses:</p> <ul style="list-style-type: none"> <li>• Manufacturing/production by the reaction of hexachlorocyclopentadiene and cis-butene-1,4-diol (forming a bicyclic diol), followed by esterification and cyclization with thionyl chloride.</li> <li>• Insecticide (including acaricide) on crops (fruits, vegetables, grains) for commercial growing (not for residential purposes).</li> </ul> <p>Releases to Air</p> <p>Emissions of endosulfan to the atmosphere are reported from agricultural spray applications and the subsequent volatilization and wind suspension.</p> <p>Releases to Soil</p> <p>Releases of endosulfan to soil are reported from direct soil application (agricultural spray), hazardous waste disposal sites, and atmospheric deposition.</p> <p>Releases to Water</p> <p>Releases of endosulfan to surface waters and groundwater are reported from agricultural spray drift applications, atmospheric deposition, runoff/erosion of contaminated soils, and contaminated hazardous waste sites (in groundwater).</p> <p>Source: (ATSDR, 2015)</p>
Transport and Fate	<p>Transformation &amp; Degradation</p> <p>Endosulfan degrades to endosulfan sulfate and endosulfan diol.</p> <ul style="list-style-type: none"> <li>• In the atmosphere, Endosulfan exists in the vapor and both isomers are expected to be photooxidized by hydroxyl radicals and with atmospheric ozone. Both isomers are considered stable to direct photolysis (they do not absorb light at wavelengths greater than 300 nanometers). The alpha isomer undergoes isomerization to the beta isomer, which is more stable. <ul style="list-style-type: none"> <li>○ In the atmosphere, breakdown products are: endosulfan sulfate.</li> </ul> </li> <li>• In water, Endosulfan is degraded by hydrolysis and oxidation (under aerobic conditions) and by hydrolysis (under anaerobic conditions), dependent on the water's pH. In sediment, endosulfan can be degraded by biotic and abiotic conditions. The degradation rate in water increases with higher pH values. The formation of degradates is dominated by hydroxyl carboxylic acid and endosulfan sulfate. <ul style="list-style-type: none"> <li>○ In water, breakdown products are: endosulfan diol.</li> <li>○ In water sediment, breakdown products are: endosulfan sulfate.</li> </ul> </li> <li>• In soil, endosulfan degrades primarily by biodegradation under aerobic and anaerobic conditions. Degradation by hydrolysis is possible in moist soils. Degradation of each isomer in soil occurs at varying rates. Degradation is dependent on soil characteristics. <ul style="list-style-type: none"> <li>○ In soil, breakdown products are: endosulfan sulfate, endosulfan diol, endosulfan lactone, and endosulfan hydroxyether.</li> </ul> </li> </ul> <p>Partitioning</p> <p>Endosulfan is stable in the atmosphere and considered semi-volatile from water and soil surfaces; endosulfan prefers to adsorb to soil, sediment, and suspended solids.</p> <ul style="list-style-type: none"> <li>• In the atmosphere, endosulfan exists primarily in the vapor phase and can be transported via</li> </ul>

spray drift, dependent on meteorological conditions. Endosulfan can undergo long-range transport in the atmosphere and atmospheric deposition.

- In water, endosulfan can volatilize from the surface, but is expected to partition to suspended solids in the water column and sediment. Endosulfan is not expected to be present in groundwater.
- In soil, endosulfan has limited mobility (dependent on soil characteristics) and limited ability of leaching to groundwater, indicating a strong tendency to sorb to soils. Endosulfan can volatilize from the surface soil (dependent on temperature and moisture). The beta isomer is less volatile than the alpha isomer.

## Bioaccumulation/Bioconcentration

Bioconcentration and bioaccumulation potential of Endosulfan in organisms varies (by organism).

Metabolism of endosulfan may significantly attenuate biomagnification in the terrestrial food chain.

Toxic Pollutant	Bioconcentration Factor	Bioaccumulation Factor
Endosulfan	17.1 to 11,583	115 to 3,260
Endosulfan I (alpha)	n/a	n/a
Endosulfan II (beta)	n/a	n/a

Note: BCF and BAF values reported for fish

Source: (ATSDR, 2015)

## Water Quality Regulations

### Oregon Water Quality Standards

Toxic Pollutant	Aquatic Life Water Quality Criteria Freshwater, Chronic (µg/L)	Aquatic Life Water Quality Guidance Values Freshwater, Chronic (µg/L)	Human Health Water Quality Criteria Water + Organism (µg/L)
Endosulfan	0.056	n/a	8.5
Endosulfan I (alpha)	0.056	n/a	8.5
Endosulfan II (beta)	0.056	n/a	8.5

Source: (DEQ, 2017)

Priority Pollutant (EPA's Clean Water Act): Yes

TRI-Listed Pollutant (EPA's EPCRA Section 313): No

Reportable Pollutant (EPA's CERCLA's Section 304): Yes

Sources: (EPA, 2014) (EPA, 2016b) (EPA, 2015)

## Abbreviations / Acronyms

atm-m<sup>3</sup>/mol – atmosphere-cubic meters per mole

CASRN – Chemical Abstract Registry Number

°C – degrees Celsius

CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act

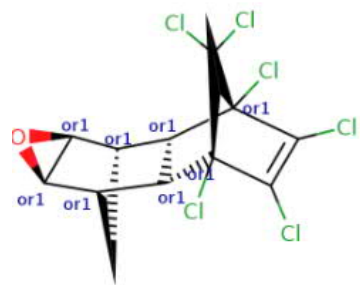
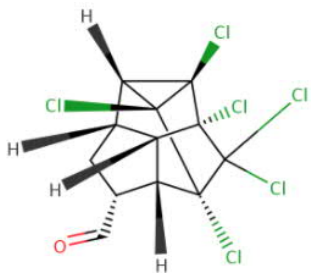
EPA – Environmental Protection Agency

EPCRA – Environmental Planning and Community Right-to-Know Act

g/cm<sup>3</sup> – grams per centimeter cubed

IUPAC – International Union of Pure and Applied Chemistry

	<p>L/kg – liters per kilogram</p> <p>log – log base 10 of K (i.e., 10<sup>K</sup>)</p> <p>mmHg – millimeters mercury</p> <p>mol/L – moles per liter</p> <p>n/a – not available / not analyzed</p> <p>µg/liter – micrograms per liter</p>
References	<p>ATSDR. (2015). Toxicological Profile for Endosulfan.  <a href="https://doi.org/http://dx.doi.org/10.1155/2013/286524">https://doi.org/http://dx.doi.org/10.1155/2013/286524</a></p> <p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p> <p>EPA. (2014). Priority Pollutant List. Retrieved from <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a></p> <p>EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <a href="https://www.epa.gov/epcra/epcracerclacaa-ss112r-consolidated-list-lists-march-2015-version">https://www.epa.gov/epcra/epcracerclacaa-ss112r-consolidated-list-lists-march-2015-version</a></p> <p>EPA. (2016a). Pesticide Reregistration Status Endosulfan Phaseout. Retrieved from <a href="https://archive.epa.gov/pesticides/reregistration/web/html/endosulfan-agreement.html">https://archive.epa.gov/pesticides/reregistration/web/html/endosulfan-agreement.html</a></p> <p>EPA. (2016b). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from <a href="https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf">https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf</a></p> <p>EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <a href="https://comptox.epa.gov/dashboard">https://comptox.epa.gov/dashboard</a></p> <p>EPA. (2018). Estimation Programs Interface Suite. Retrieved from <a href="https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface#citing">https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface#citing</a></p> <p>SRC. (2013). FatePointers Search Module, PhysProp. Retrieved December 1, 2017, from <a href="http://esc.srcinc.com/fatepointer/search.asp">http://esc.srcinc.com/fatepointer/search.asp</a></p>

Profile	Classification: Organochlorine Insecticide																																	
	CASRN: 72-20-8																																	
	Molecular Formula: C <sub>12</sub> H <sub>8</sub> Cl <sub>6</sub>																																	
	IUPAC Name: 2,7:3,6-Dimethanonaph(2,3-b)oxirene																																	
		Endrin																																
	Synonyms: Hexadrin; 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4A,5,6,7,8,8A-octahydroendo; endo-1,4:5,8-dimethanonaphthalene																																	
		Endrin Aldehyde																																
	Source: (ATSDR, 1996; EPA, 2017)																																	
	Description																																	
	Endrin is a man-made pesticide that exists as a white, odorless solid. General use and manufacturing began in 1951; endrin was cancelled in 1986 and 1991 (for other uses). Limited information is known about endrin aldehyde (the breakdown product and impurity of endrin).																																	
Chemical Characteristics																																		
	<table><tr><th>Toxic Pollutant Isomer</th><th>Endrin (72-20-8)</th><th>Endrin Aldehyde (7421-93-4)</th></tr><tr><td>Molecular Weight (g/mol)</td><td>381</td><td>381</td></tr><tr><td>Density (g/cm<sup>3</sup>)</td><td>1.85 @ 25°C</td><td>n/a</td></tr><tr><td>Water Solubility (mg/L)</td><td>0.250 @ 25°C</td><td>0.024 @ 25°C</td></tr><tr><td>Boiling Point (°C)</td><td>330</td><td>n/a</td></tr><tr><td>Melting Point (°C)</td><td>176</td><td>235</td></tr><tr><td>Octanol-water coefficient (log K<sub>ow</sub>)</td><td>5.20</td><td>5.60</td></tr><tr><td>Octanol-air coefficient (log K<sub>oa</sub>)</td><td>8.79</td><td>8.92</td></tr><tr><td>Organic carbon-water coefficient (log K<sub>oc</sub>)</td><td>3.17</td><td>3.17</td></tr><tr><td>Vapor Pressure (mmHg)</td><td>3.00x10<sup>-6</sup> @ 25°C</td><td>2.00x10<sup>-7</sup> @ 25°C</td></tr><tr><td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td>6.36x10<sup>-6</sup> @ 25°C</td><td>3.67x10<sup>-8</sup> @ 25°C</td></tr></table>	Toxic Pollutant Isomer	Endrin (72-20-8)	Endrin Aldehyde (7421-93-4)	Molecular Weight (g/mol)	381	381	Density (g/cm <sup>3</sup> )	1.85 @ 25°C	n/a	Water Solubility (mg/L)	0.250 @ 25°C	0.024 @ 25°C	Boiling Point (°C)	330	n/a	Melting Point (°C)	176	235	Octanol-water coefficient (log K <sub>ow</sub> )	5.20	5.60	Octanol-air coefficient (log K <sub>oa</sub> )	8.79	8.92	Organic carbon-water coefficient (log K <sub>oc</sub> )	3.17	3.17	Vapor Pressure (mmHg)	3.00x10 <sup>-6</sup> @ 25°C	2.00x10 <sup>-7</sup> @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	6.36x10 <sup>-6</sup> @ 25°C	3.67x10 <sup>-8</sup> @ 25°C
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	Sources: (ATSDR, 1996; EPA, 2018; SRC, 2013)																																	
Organic Solvents																																		
Soluble in acetone, benzene, carbon tetrachloride, hexane, and xylene (at varying concentrations). Solubility of endrin aldehyde is not reported.																																		
Source: (ATSDR, 1996)																																		

Sources	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>• None</li> </ul> <p>Non-natural Sources/Uses:</p> <ul style="list-style-type: none"> <li>• Manufacturing/production by the reaction of vinyl chloride and hexachlorocyclopentadiene, dechlorinated and condensed with cyclopentadiene to produce isodrin, and epoxidized with peracetic or perbenzoic acid (historical).</li> <li>• Insecticide (rodenticide and avicide) on crops (cotton, sugarcane, tobacco, apple orchards, and grains)</li> </ul> <p>Releases to Air</p> <p>Emissions of endrin to the atmosphere are reported from manufacturing facilities (historical), from agricultural spray applications, and the subsequent volatilization and wind suspension. Endrin is also reported from hazardous waste sites. Detections of endrin aldehyde in air are not reported.</p> <p>Releases to Soil</p> <p>Releases of endrin to soil are reported from manufacturing facilities (historical), direct soil application of agricultural spray (no longer occurring), and atmospheric deposition. Endrin is also reported from hazardous waste sites. Detections of endrin aldehyde in soil/sediment and hazardous waste sites are not reported.</p> <p>Releases to Water</p> <p>Releases of endrin to surface waters and groundwater are reported from manufacturing facilities (no longer occurring), agricultural spray drift applications (historical), atmospheric deposition, runoff/erosion of contaminated soils (historical direct applications). Endrin is also reported from contaminated hazardous waste sites (in groundwater). Detections of endrin aldehyde in surface water, groundwater, and hazardous waste sites are not reported.</p> <p>Source: (ATSDR, 1996)</p>
Transport and Fate	<p>Transformation &amp; Degradation</p> <p>Endrin is a stereoisomer of dieldrin. Endrin degrades to endrin aldehyde (an impurity) and endrin ketone.</p> <ul style="list-style-type: none"> <li>• In the atmosphere, endrin can undergo photodegradation, photochemical isomerization, photolytic dechlorination (in ultraviolet radiation exposure), and degrade by heat. The reaction of endrin with atmospheric ozone is not significant. <ul style="list-style-type: none"> <li>◦ In the atmosphere, endrin aldehyde may react with photochemically generated hydroxyl radicals.</li> <li>◦ In the atmosphere, breakdown products are: pentacyclic ketone, endrin aldehyde, and pentacyclic ketone (i.e., detal ketoendrin or endrin ketone) (from endrin).</li> </ul> </li> <li>• In water, endrin has a significant degree of stability but biodegradation is possible, with little indication of chemical degradation. Endrin undergoes degradation by microorganisms. Degradation in domestic wastewater samples is not reported. In surface water, endrin can undergo photoisomerization; biodegradation and hydrolysis are not expected to be significant. <ul style="list-style-type: none"> <li>◦ In water, degradation of endrin aldehyde is not known.</li> <li>◦ In water, breakdown products are: endrin ketone and endrin aldehyde (from endrin).</li> </ul> </li> <li>• In soil, endrin is not expected to degrade significantly by biodegradation and is resistant under natural conditions. Degradation is reported for endrin under laboratory conditions,</li> </ul>



dependent on soil characteristics. Volatilization, photodegradation, and heat transformations account for rapid decreases in endrin concentrations from soil/plant surfaces.

- In soil, degradation of endrin aldehyde is not reported.
- In soil, breakdown products are: endrin aldehyde, endrin ketone, and endrin alcohol.

## Partitioning

Endrin is extremely persistent in the environment, primarily sorbing to sediments and soil particles, but is volatile from surface soils (after direct application).

- In the atmosphere, endrin exists primarily with particulate matter, but small amounts may exist in the vapor phase. Endrin is not expected to undergo significant wet deposition (due to its low water solubility).
  - Endrin aldehyde is expected to exist primarily in the adsorbed phase.
- In water, endrin sorbs strongly to soil particles in the water column and sediments. Endrin partitions little from water to air (due to a low Henry's law constant). Endrin is not expected to be present in groundwater, unless in the presence of organic solvents. Adsorption to sediment may reduce the volatilization rate from water.
  - Endrin aldehyde is not expected to volatilize from surface waters and adsorption to sediments is likely to be significant.
- In soil, endrin sorbs strongly to soil particles and migration to groundwater would generally not be expected. However, leaching to groundwater can occur depending on soil characteristics and the endrin formulation (i.e., with xylene or hexane carriers). Volatilization from soil surface is rapid but short lived.
  - Low mobility of endrin aldehyde is reported (due to a high octanol-water partition coefficient and soil adsorption). Endrin aldehyde is not expected to volatilize from soil.

## Bioaccumulation/Bioconcentration

Significant uptake of endrin occurs in plants and aquatic organisms. Endrin bioconcentrates significantly in aquatic organisms. Increasing biomagnification of endrin with increasing trophic levels is not expected to be significant.

Toxic Pollutant	Bioconcentration Factor	Bioaccumulation Factor
Endrin	80 to 49,000	2
Endrin Aldehyde	2,000 to 11,000	n/a

Note: BCF and BAF values reported for fish

Source: (ATSDR, 1996)

## Water Quality Regulations

### Oregon Water Quality Standards

Pollutant	Aquatic Life Water Quality Criteria	Aquatic Life Water Quality Guidance Values	Human Health Water Quality Criteria
	Freshwater, Chronic (µg/L)	Freshwater, Chronic (µg/L)	Water + Organism (µg/L)
Endrin	0.036	n/a	0.024
Endrin Aldehyde	n/a	n/a	0.030

Source: (DEQ, 2017)

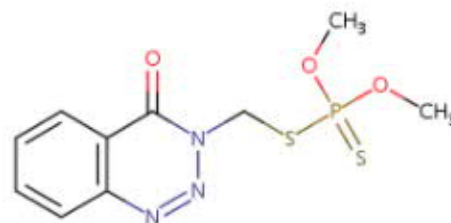
	<p>Priority Pollutant (EPA's Clean Water Act): Yes (endrin and endrin aldehyde)</p> <p>TRI-Listed Pollutant (EPA's EPCRA Section 313): No</p> <p>Reportable Pollutant (EPA's CERCLA's Section 304): Yes</p> <p><u>Source:</u> (EPA, 2014, 2015, 2016)</p>
Abbreviations / Acronyms	<p>atm-m<sup>3</sup>/mol – atmosphere-cubic meters per mole</p> <p>CASRN – Chemical Abstract Registry Number</p> <p>°C – degrees Celsius</p> <p>CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act</p> <p>EPA – Environmental Protection Agency</p> <p>EPCRA – Environmental Planning and Community Right-to-Know Act</p> <p>g/cm<sup>3</sup> – grams per centimeter cubed</p> <p>IUPAC – International Union of Pure and Applied Chemistry</p> <p>L/kg – liters per kilogram</p> <p>log – log base 10 of K (i.e., 10<sup>K</sup>)</p> <p>mmHg – millimeters mercury</p> <p>mol/L – moles per liter</p> <p>n/a – not available / not analyzed</p> <p>µg/liter – micrograms per liter</p>
References	<p>ATSDR. (1996). Toxicological Profile for Endrin.  <a href="https://doi.org/http://dx.doi.org/10.1155/2013/286524">https://doi.org/http://dx.doi.org/10.1155/2013/286524</a></p> <p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from  <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p> <p>EPA. (2014). Priority Pollutant List. Retrieved from  <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a></p> <p>EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <a href="https://www.epa.gov/epcra/epcracerclacaa-ss112r-consolidated-list-lists-march-2015-version">https://www.epa.gov/epcra/epcracerclacaa-ss112r-consolidated-list-lists-march-2015-version</a></p> <p>EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from <a href="https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf">https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf</a></p> <p>EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <a href="https://comptox.epa.gov/dashboard">https://comptox.epa.gov/dashboard</a></p>

	EPA. (2018). Estimation Programs Interface Suite. Retrieved from <a href="https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface#citing">https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface#citing</a>
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	SRC. (2013). FatePointers Search Module, PhysProp. Retrieved December 1, 2017, from <a href="http://esc.srcinc.com/fatepointer/search.asp">http://esc.srcinc.com/fatepointer/search.asp</a>
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# Toxic Pollutant Profile | Azinphos-methyl (Guthion)

<p>Profile</p>	<p>Classification: Organophosphorus Insecticide</p> <p>CASRN: 86-50-0</p> <p>Molecular Formula: <math>C_{10}H_{12}N_3O_3PS_2</math></p> <p>IUPAC Name: 3-(dimethoxyphosphinothioylsulfanylmethyl)-1,2,3-benzotriazin-4-one</p> <p>Synonyms: Azinphosmethyl; Guthion</p> <p>Source: (ATSDR, 2008; EPA, 2017)</p> <p>Description Guthion, the common name, is a man-made insecticide that exists as a colorless to white or cream to yellow brown crystalline (granular) solid. Many of its former uses have been cancelled and complete phase-out occurred by 2013 (different years of phase out occurred for different agricultural crops).</p> <p>Chemical Characteristics</p> <table border="1"> <tr> <td>Molecular Weight (g/mol)</td><td>317</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>1.45 @ 25°C</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>28 @ 25°C</td></tr> <tr> <td>Boiling Point (°C)</td><td>200°C (decomposes above this value)</td></tr> <tr> <td>Melting Point (°C)</td><td>74</td></tr> <tr> <td>Octanol-water coefficient (log <math>K_{ow}</math>)</td><td>2.75</td></tr> <tr> <td>Octanol-air coefficient (log <math>K_{oa}</math>)</td><td>9.68</td></tr> <tr> <td>Organic carbon-water coefficient (log <math>K_{oc}</math>)</td><td>2.53</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td><math>2.20 \times 10^{-7}</math> @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td><math>3.70 \times 10^{-9}</math> @ 25°C</td></tr> </table> <p>Source: (ATSDR, 2008; EPA, 2018)</p> <p>Organic Solvents Soluble in dichloroethane, acetone, acetonitrile, ethyl acetate, and DMSO (at &gt;250 g/L, 20°C). Soluble in n-heptane (at 1.2 g/L, 20°C). Soluble in xylene (at 170 g/L, 20°C).</p> <p>Source: (ATSDR, 2008; EPA, 2016a)</p>	Molecular Weight (g/mol)	317	Density (g/cm <sup>3</sup> )	1.45 @ 25°C	Water Solubility (mg/L)	28 @ 25°C	Boiling Point (°C)	200°C (decomposes above this value)	Melting Point (°C)	74	Octanol-water coefficient (log $K_{ow}$ )	2.75	Octanol-air coefficient (log $K_{oa}$ )	9.68	Organic carbon-water coefficient (log $K_{oc}$ )	2.53	Vapor Pressure (mmHg)	$2.20 \times 10^{-7}$ @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	$3.70 \times 10^{-9}$ @ 25°C
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Henry's Law Constant (atm-m <sup>3</sup> /mol)	$3.70 \times 10^{-9}$ @ 25°C																				
<p>Sources</p>	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>None</li> </ul> <p>Non-natural Sources/Uses:</p> <ul style="list-style-type: none"> <li>Manufacturing/production by the reaction of N-bromethylazimidobenzoyl with sodium deimethyldithiophosphoric acid (legacy)</li> <li>Insecticide (including acaricide and molluscicide) on crops (apple orchards, nut trees, nursery plants, fruits, and vegetables) (legacy)</li> <li>Insecticide on crops (almonds, apples/crabapples, blueberries, lowbush and highbush, Brussel sprouts, cherries, nursery stock, parsley, pears, pistachios, and walnuts) (allowed current use)</li> </ul>																				



# Toxic Pollutant Profile | Azinphos-methyl (Guthion)

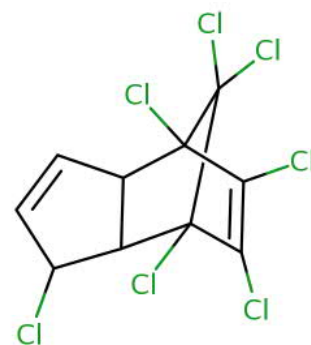
	<p><b>Releases to Air</b> Emissions of azinphos-methyl to the atmosphere are reported from agricultural spray applications and subsequent volatilization and wind suspension.</p> <p><b>Releases to Soil</b> Releases of azinphos-methyl to soil are reported from direct soil application (agricultural spray), hazardous waste disposal sites, and atmospheric deposition.</p> <p><b>Releases to Water</b> Releases of azinphos-methyl to surface waters and groundwater are reported from agricultural spray drift applications, atmospheric deposition, runoff/erosion of contaminated soils, and contaminated hazardous waste sites (in groundwater).</p> <p><u>Source:</u> (ATSDR, 2008)</p>
<p><b>Transport and Fate</b></p>	<p><b>Transformation &amp; Degradation</b> Azinphos-methyl is not highly persistent in the environment and degrades to several metabolites.</p> <ul style="list-style-type: none"> <li>• In the atmosphere, azinphos-methyl exists in the vapor and particulate phases. In the vapor-phase, azinphos-methyl is expected to rapidly degrade through reactions with photochemically produced hydroxyl radicals and direct photolysis. <ul style="list-style-type: none"> <li>◦ In the atmosphere, breakdown products are: thiophosphoric acid O,S,O'-trimethyl ester; dithiophosphoric acid O,S,S'-trimethyl ester; and dithiophosphoric acid O,S,O'-trimethyl ester.</li> </ul> </li> <li>• In water, azinphos-methyl is degraded through biotic and abiotic mechanisms, including hydrolysis and aqueous photolysis. Degradation is increased with increases in pH; hydrolysis and biodegradation are attenuated at low temperatures. In chlorinated systems, chemical oxidation of the thiophosphate group leads to formation of azinphos-methyl oxygenated metabolites. <ul style="list-style-type: none"> <li>◦ In water, breakdown products are: mercaptomethyl benzazimide; hydroxymethyl benzazimide; benzazimide; anthranilic acid; and bismethyl benzazamide sulfide.</li> </ul> </li> <li>• In soil, azinphos-methyl undergoes biodegradation, photolysis, and hydrolysis at varying rates, dependent on soil characteristics. Biodegradation is likely the major transformation pathway, under normal environmental conditions. Rapid degradation is likely in soils with more alkalinity and organic matter. <ul style="list-style-type: none"> <li>◦ In soil, breakdown products are: mercaptomethyl benzazimide; hydroxymethyl benzazimide; benzazimide; and bismethyl benzazamide sulfide.</li> </ul> </li> </ul> <p><b>Partitioning</b> Azinphos-methyl is essentially nonvolatile from water and soil surfaces and prefers to adsorb to soil and sediment (and suspended solids).</p> <ul style="list-style-type: none"> <li>• In the atmosphere, azinphos-methyl can be transported via spray drift, dependent on meteorological conditions. Azinphos-methyl does not undergo long-range transport in the atmosphere, but it can undergo wet and dry atmospheric deposition.</li> <li>• In water, azinphos-methyl is expected to adsorb to suspended soils and sediment in the water column. The aqueous phase and sediment compartments are important environmental sinks in surface water.</li> <li>• In soil, azinphos-methyl has moderate to low soil mobility and the potential of leaching to groundwater is low.</li> </ul>

# Toxic Pollutant Profile | Azinphos-methyl (Guthion)

	<p>Bioaccumulation/Bioconcentration</p> <p>Bioconcentration and bioaccumulation of azinphos-methyl in aquatic organisms is expected to be low to moderate. Azinphos-methyl can be taken up by plant roots and be transported throughout, undegraded.</p> <table><tr><td>Bioconcentration Factor</td><td>Bioaccumulation Factor</td></tr><tr><td>26 to 3,000</td><td>n/a</td></tr></table> <p><u>Note:</u> BCF and BAF values reported for fish</p> <p><u>Source:</u> (ATSDR, 2008)</p>	Bioconcentration Factor	Bioaccumulation Factor	26 to 3,000	n/a					
Bioconcentration Factor	Bioaccumulation Factor									
26 to 3,000	n/a									
Water Quality Regulations	<p>Oregon Water Quality Standards</p> <table><tr><td>Aquatic Life Water Quality Criteria</td><td>Aquatic Life Water Quality Guidance Values</td><td>Human Health Water Quality Criteria</td></tr><tr><td>Freshwater, Chronic (µg/L)</td><td>Freshwater, Chronic (µg/L)</td><td>Water + Organism (µg/L)</td></tr><tr><td>0.01</td><td>n/a</td><td>n/a</td></tr></table> <p><u>Source:</u> (DEQ, 2017)</p> <p>Priority Pollutant (EPA’s Clean Water Act): No TRI-Listed Pollutant (EPA’s EPCRA Section 313): No Reportable Pollutant (EPA’s CERCLA’s Section 304): Yes</p> <p><u>Source:</u> (EPA, 2014) (EPA, 2016b) (EPA, 2015)</p>	Aquatic Life Water Quality Criteria	Aquatic Life Water Quality Guidance Values	Human Health Water Quality Criteria	Freshwater, Chronic (µg/L)	Freshwater, Chronic (µg/L)	Water + Organism (µg/L)	0.01	n/a	n/a
Aquatic Life Water Quality Criteria	Aquatic Life Water Quality Guidance Values	Human Health Water Quality Criteria								
Freshwater, Chronic (µg/L)	Freshwater, Chronic (µg/L)	Water + Organism (µg/L)								
0.01	n/a	n/a								
Abbreviations / Acronyms	<p>atm-m<sup>3</sup>/mol – atmosphere-cubic meters per mole</p> <p>CASRN – Chemical Abstract Registry Number</p> <p>°C – degrees Celsius</p> <p>CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act</p> <p>EPA – Environmental Protection Agency</p> <p>EPCRA – Environmental Planning and Community Right-to-Know Act</p> <p>g/cm<sup>3</sup> – grams per centimeter cubed</p> <p>IUPAC – International Union of Pure and Applied Chemistry</p> <p>L/kg – liters per kilogram</p> <p>log – log base 10 of K (i.e., 10<sup>K</sup>)</p> <p>mmHg – millimeters mercury</p> <p>mol/L – moles per liter</p> <p>n/a – not available / not analyzed</p> <p>µg/liter – micrograms per liter</p>									
References	<p>ATSDR. (2008). Toxicological Profile for Guthion. Retrieved from <a href="https://www.atsdr.cdc.gov/toxprofiles/index.asp#D">https://www.atsdr.cdc.gov/toxprofiles/index.asp#D</a></p> <p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p>									

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|  | <p>EPA. (2014). Priority Pollutant List. Retrieved from <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a></p> <p>EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <a href="https://www.epa.gov/epcra/epcracerclaaa-ss112r-consolidated-list-lists-march-2015-version">https://www.epa.gov/epcra/epcracerclaaa-ss112r-consolidated-list-lists-march-2015-version</a></p> <p>EPA. (2016a). Pesticide Reregistration Status Azinphos Methyl Phaseout. Retrieved from <a href="https://archive.epa.gov/pesticides/reregistration/web/html/phaseout_fs.html">https://archive.epa.gov/pesticides/reregistration/web/html/phaseout_fs.html</a></p> <p>EPA. (2016b). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from <a href="https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf">https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf</a></p> <p>EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <a href="https://comptox.epa.gov/dashboard">https://comptox.epa.gov/dashboard</a></p> <p>EPA. (2018). Estimation Programs Interface Suite. Retrieved from <a href="https://www.epa.gov/tsca-screening-tools/epi-suite-tm-estimation-program-interface#cite">https://www.epa.gov/tsca-screening-tools/epi-suite-tm-estimation-program-interface#cite</a></p> |
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<p>Profile</p>	<p>Classification: Organochlorine Insecticide</p> <p>CASRN: 76-44-8</p> <p>Molecular Formula: <math>C_{10}H_5Cl_7</math></p> <p>IUPAC Name: Heptachlor</p> <p>Synonyms: Heptachlorane; 3-Chlorochlordene</p> <p>Source: (ATSDR, 2007; EPA, 2017)</p> <p>Description</p> <p>Heptachlor is a man-made chemical, existing as a white powder. Heptachlor was used as an insecticide from 1953 to 1979 and banned by 1988.</p> <p>Chemical Characteristics</p> <table border="1"> <tr> <td>Molecular Weight (g/mol)</td><td>373</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>1.81 @ 25°C</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>0.050 @ 25°C</td></tr> <tr> <td>Boiling Point (°C)</td><td>145</td></tr> <tr> <td>Melting Point (°C)</td><td>96</td></tr> <tr> <td>Octanol-water coefficient (log <math>K_{ow}</math>)</td><td>6.10</td></tr> <tr> <td>Octanol-air coefficient (log <math>K_{oa}</math>)</td><td>9.23</td></tr> <tr> <td>Organic carbon-water coefficient (log <math>K_{oc}</math>)</td><td>5.29</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td><math>3.00 \times 10^{-4}</math> @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td><math>2.94 \times 10^{-4}</math> @ 25°C</td></tr> </table> <p>Source: (ATSDR, 2007; EPA, 2018)</p> <p>Organic Solvents</p> <p>Soluble in most organic solvents</p> <p>Source: (ATSDR, 2007)</p>	Molecular Weight (g/mol)	373	Density (g/cm <sup>3</sup> )	1.81 @ 25°C	Water Solubility (mg/L)	0.050 @ 25°C	Boiling Point (°C)	145	Melting Point (°C)	96	Octanol-water coefficient (log $K_{ow}$ )	6.10	Octanol-air coefficient (log $K_{oa}$ )	9.23	Organic carbon-water coefficient (log $K_{oc}$ )	5.29	Vapor Pressure (mmHg)	$3.00 \times 10^{-4}$ @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	$2.94 \times 10^{-4}$ @ 25°C
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<p>Sources</p>	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>None</li> </ul> <p>Non-natural Sources &amp; Uses:</p> <ul style="list-style-type: none"> <li>Manufacturing/production by the free-radical chlorination of chlordane in benzene (legacy)</li> <li>Insecticide on soil, seeds (corn, grain, sorghum), citrus, and termites (legacy)</li> <li>Insecticide on fire ants in underground power transformers (potentially legacy)</li> </ul> <p>Releases to Air</p> <p>Emissions of heptachlor to the atmosphere are reported from manufacturing/processing facilities.</p> <p>Releases to Soil</p> <p>Releases of heptachlor to soil are reported from manufacturing/processing facilities, hazardous waste disposal sites, and wet deposition.</p>																				

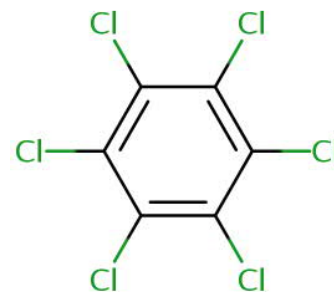




	<p>Releases to Water</p> <p>Releases of heptachlor to surface waters and groundwater are reported from manufacturing/processing facilities, hazardous waste disposal sites, contaminated wastewater discharges, stormwater runoff from contaminated soils, and wet deposition.</p> <p>Source: (ATSDR, 2007)</p>									
Transport and Fate	<p>Transformation &amp; Degradation</p> <p>Heptachlor is a breakdown product and component of chlordane. Heptachlor is broken down to heptachlor epoxide and 1-hydroxychlordene.</p> <ul style="list-style-type: none"><li>• In the atmosphere, heptachlor can undergo direct photolysis and is susceptible to photosensitized reactions.</li><li>• In water, heptachlor is hydrolyzed at the surface. The major pathway in aquatic systems is rapid abiotic hydrolysis followed by metabolism (by freshwater microcrustaceans).</li><li>• In soil, heptachlor is slowly degraded by soil microorganisms.</li><li>• Anaerobic digested waste and composting (of biosolid and municipal solid waste) have shown degradation of heptachlor.</li></ul> <p>Partitioning</p> <p>Heptachlor partitions rapidly to the atmosphere from water but has a high sorption tendency for adsorbing to soil.</p> <ul style="list-style-type: none"><li>• In the atmosphere, heptachlor can undergo long-range transport and wet atmospheric deposition.</li><li>• In water, heptachlor volatilizes rapidly from the surface but adsorbs strongly to suspended and bottom sediment.</li><li>• In soil, heptachlor may volatilize from the surface, but adsorbs strongly to soil and is not likely to leach into groundwater (due to its high soil organic carbon adsorption coefficient). The organic matter content of soil determines its leachability (i.e., less likely to leach from soil with high organic matter content).</li></ul> <p>Bioaccumulation/Bioconcentration</p> <p>Heptachlor exhibits a high potential for bioaccumulation and biomagnification in the aquatic food chain. However, biomagnification of heptachlor is not significant as it is readily metabolized to heptachlor epoxide.</p> <p>Source: (ATSDR, 2007)</p>									
Water Quality Regulations	<p>Oregon Water Quality Standards</p> <table><tr><th>Aquatic Life Water Quality Criteria</th><th>Aquatic Life Water Quality Guidance Values</th><th>Human Health Water Quality Criteria</th></tr><tr><td>Freshwater, Chronic (µg/L)</td><td>Freshwater, Chronic (µg/L)</td><td>Water + Organism (µg/L)</td></tr><tr><td>0.0038</td><td>n/a</td><td>0.0000079</td></tr></table> <p>Source: (DEQ, 2017)</p> <p>Priority Pollutant (EPA’s Clean Water Act): Yes</p> <p>TRI-Listed Pollutant (EPA’s EPCRA Section 313): Yes</p> <p>Reportable Pollutant (EPA’s CERCLA’s Section 304): Yes</p> <p>Source: (EPA, 2014, 2015, 2016)</p>	Aquatic Life Water Quality Criteria	Aquatic Life Water Quality Guidance Values	Human Health Water Quality Criteria	Freshwater, Chronic (µg/L)	Freshwater, Chronic (µg/L)	Water + Organism (µg/L)	0.0038	n/a	0.0000079
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Abbreviations / Acronyms	<p>atm-m<sup>3</sup>/mol – atmosphere-cubic meters per mole</p> <p>CASRN – Chemical Abstract Registry Number</p> <p>CERCLA – Comprehensive Environmental Response, Compensation and Liability Act</p> <p>°C – degrees Celsius</p> <p>EPA – Environmental Protection Agency</p> <p>EPCRA – Environmental Planning and Community Right-to-Know Act</p> <p>g/cm<sup>3</sup> – grams per centimeter cubed</p> <p>IUPAC – International Union of Pure and Applied Chemistry</p> <p>L/kg – liters per kilogram</p> <p>log – log base 10 of K (i.e., 10<sup>K</sup>)</p> <p>mmHg – millimeters mercury</p> <p>mol/L – moles per liter</p> <p>n/a – not available / not analyzed</p> <p>µg/liter – micrograms per liter</p>
References	<p>ATSDR. (2007). Toxicological Profile for Heptachlor and Heptachlor Epoxide. Retrieved from <a href="https://www.atsdr.cdc.gov/toxprofiles/index.asp#D">https://www.atsdr.cdc.gov/toxprofiles/index.asp#D</a></p> <p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p> <p>EPA. (2014). Priority Pollutant List. Retrieved from <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a></p> <p>EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <a href="https://www.epa.gov/epcra/epcracerclacaa-ss112r-consolidated-list-lists-march-2015-version">https://www.epa.gov/epcra/epcracerclacaa-ss112r-consolidated-list-lists-march-2015-version</a></p> <p>EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from <a href="https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf">https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf</a></p> <p>EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <a href="https://comptox.epa.gov/dashboard">https://comptox.epa.gov/dashboard</a></p> <p>EPA. (2018). Estimation Programs Interface Suite. Retrieved from <a href="https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface# citing">https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface# citing</a></p>

<p>Profile</p>	<p>Classification: Organochlorine Insecticide</p> <p>CASRN: 118-74-1</p> <p>Molecular Formula: C<sub>6</sub>Cl<sub>6</sub></p> <p>IUPAC Name: 1,2,3,4,5,6-Hexachlorobenzene</p> <p>Synonyms: HCB; Perchlorobenzene; Pentachlorophenyl chloride</p> <p>Source: (EPA, 2017)</p> <p>Description</p> <p>Hexachlorobenzene is a chlorinated hydrocarbon that is a white, crystalline solid at room temperature. Hexachlorobenzene was manufactured beginning in the late 1940s/early 1950s through the late 1970s and used as a fungicide (through 1984); it has been banned in the U.S. since 1966 and globally since 2004.</p> <p>Chemical Characteristics</p> <table border="1"> <tr> <td>Molecular Weight (g/mol)</td><td>285</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>1.76 @ 25°C</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>0.0062 @ 25°C</td></tr> <tr> <td>Boiling Point (°C)</td><td>325</td></tr> <tr> <td>Melting Point (°C)</td><td>232</td></tr> <tr> <td>Octanol-water partitioning coefficient (log K<sub>ow</sub>)</td><td>5.73</td></tr> <tr> <td>Octanol-air partitioning coefficient (log K<sub>oa</sub>)</td><td>7.24</td></tr> <tr> <td>Soil organic carbon-water partitioning coefficient (log K<sub>oc</sub>)</td><td>4.24</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td>1.80x10<sup>-5</sup> @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td>0.0017 @ 25°C</td></tr> </table> <p>Source: (ATSDR, 2015; EPA, 2018; SRC, 2013)</p> <p>Organic Solvents</p> <p>Insoluble in water, slightly soluble in ethanol, soluble in diethyl ether and chloroform, and very soluble in benzene.</p> <p>Source: (ATSDR, 2015; EPA, 1990)</p>	Molecular Weight (g/mol)	285	Density (g/cm <sup>3</sup> )	1.76 @ 25°C	Water Solubility (mg/L)	0.0062 @ 25°C	Boiling Point (°C)	325	Melting Point (°C)	232	Octanol-water partitioning coefficient (log K <sub>ow</sub> )	5.73	Octanol-air partitioning coefficient (log K <sub>oa</sub> )	7.24	Soil organic carbon-water partitioning coefficient (log K <sub>oc</sub> )	4.24	Vapor Pressure (mmHg)	1.80x10 <sup>-5</sup> @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	0.0017 @ 25°C
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<p>Sources</p>	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>None</li> </ul> <p>Non-natural Sources &amp; Uses:</p> <ul style="list-style-type: none"> <li>Produced from benzene and excess chlorine reactions</li> <li>Manufacturing byproduct of: chlorinated solvents (e.g., tetrachlorethylene, trichloroethylene); chlorinated compounds (e.g., vinyl chloride, chloroanil), and pesticides (pentachloronitrobenene, tetrachloroisophthalonitrile, 4-amino-3,5,6-trichloropicolinic acid, and pentachlorophenol); and pesticides (atrazine, propazine, and simazine)</li> <li>Byproduct of processes that produce dioxins or dibenzofurans (e.g., pulp and paper mills using chlorine)</li> <li>Byproduct in waste streams of chlor-alkali plants and wood preserving plants</li> <li>Byproduct in fly ash and flue gas effluents from municipal incineration</li> <li>Fungicide (onions, sorghum, wheat, and other grains seeds)</li> </ul>																				



	<ul style="list-style-type: none"> <li>• Production of pyrotechnic/ordnance materials for the military</li> <li>• Production of synthetic rubber</li> <li>• Porosity controller in electrodes</li> <li>• Dye manufacturing chemical intermediate</li> <li>• Wood preservative</li> </ul> <p>Releases to Air Emissions of hexachlorobenzene to the atmosphere are reported from manufacturing/processing of chlorinated solvents, municipal refuse incineration, cement plant emissions, historical seed fungicide and pesticide spray applications, pyrotechnic mixtures producing smoke, and fireplace and woodstove combustion.</p> <p>Releases to Soil Releases of hexachlorobenzene to soil are reported from manufacturing/processing facilities and underground injection control, direct application of fungicides and pesticides, leaching from land disposal (i.e., landfills) of contaminated wastes,</p> <p>Releases to Water Releases of hexachlorobenzene to surface waters and groundwater are reported from manufacturing/processing of chemical solvents, discharges to wastewater treatment facilities, and runoff from land treated with fungicides and pesticides.</p> <p><u>Source:</u> (ATSDR, 2015)</p>
Transport and Fate	<p>Transformation &amp; Degradation Hexachlorobenzene degrades (i.e., dechlorinates) via anaerobic biodegradation as follows:</p> <ul style="list-style-type: none"> <li>• Hexachlorobenzene to pentachlorobenzene, to 1,2,3,5-tetrachlorobenzene to 1,3,5-trichlorobenzene</li> <li>• Hexachlorobenzene to pentachlorobenzene to 1,2,4,5-tetrachlorobenzene to 1,2,4-trichlorobenzene to dichlorobenzenes (i.e., 1,2-, 1,3-, and 1,4-dichlorobenzene)</li> </ul> <p>Hexachlorobenzene degrades (i.e., dechlorinates) in aquatic sediments via sulfidogenic conditions as follows:</p> <ul style="list-style-type: none"> <li>• Hexachlorobenzene to pentachlorobenzene to 1,2,3,5-tetrachlorobenzene to 1,3,5-trichlorobenzene to 1,3-dichlorobenzene</li> </ul> <p>Hexachlorobenzene degrades (i.e., dechlorinates) in aquatic sediments via methanogenic conditions as follows:</p> <ul style="list-style-type: none"> <li>• Hexachlorobenzene to pentachlorobenzene to 1,2,3,4-tetrachlorobenzene to 1,2,4-trichlorobenzene to 1,4-dichlorobenzene</li> <li>• In the atmosphere, hexachlorobenzene is generally photochemically stable and degradation is extremely slow.</li> <li>• In water, hexachlorobenzene is persistent and does not readily degrade by either abiotic or biotic processes; it is generally resistant to hydrolysis but shows removal rates via photolysis and ozone reactions in water.</li> <li>• In soil, hexachlorobenzene is not significantly degraded by abiotic or biodegradation processes.</li> </ul>

	<p>Partitioning</p> <p>Hexachlorobenzene is persistent due to its stability and resistance to degradation.</p> <ul style="list-style-type: none"><li>• In air, hexachlorobenzene exists primarily in the vapor phase (but also associated with particulates) and is able to undergo long-range atmospheric transport from temperate to polar regions. Hexachlorobenzene is able to washout via dry and wet atmospheric deposition, but is primarily resistant to wet (due to its low solubility).</li><li>• In water, hexachlorobenzene will partition from the water column into sediment and suspended particulate matter. Hexachlorobenzene can volatilize from water, but slowly (due to its strong adsorption to particulates/organic matter).</li><li>• In soil, hexachlorobenzene can volatilize, but will be strongly adsorbed to organic matter and is generally considered immobile, and thus, is unlikely to leach into groundwater.</li></ul> <p>Bioaccumulation/Bioconcentration</p> <p>Hexachlorobenzene bioconcentrates and bioaccumulates significantly in terrestrial and aquatic food chains.</p> <table><tr><th>Bioconcentration Factor</th><th>Bioaccumulation Factor (log)</th></tr><tr><td>5,500 to 21,900</td><td>5.8 to 6.03</td></tr></table> <p>Note: BCF and BAF values reported for fish</p> <p>Source: (ATSDR, 2015)</p>	Bioconcentration Factor	Bioaccumulation Factor (log)	5,500 to 21,900	5.8 to 6.03					
Bioconcentration Factor	Bioaccumulation Factor (log)									
5,500 to 21,900	5.8 to 6.03									
Water Quality Regulations	<p>Oregon Water Quality Standards</p> <table><tr><th>Aquatic Life Water Quality Criteria</th><th>Aquatic Life Water Quality Guidance Values</th><th>Human Health Water Quality Criteria</th></tr><tr><th>Freshwater, Chronic (µg/L)</th><th>Freshwater, Chronic (µg/L)</th><th>Water + Organism (µg/L)</th></tr><tr><td>n/a</td><td>n/a</td><td>0.000029</td></tr></table> <p>Source: (DEQ, 2017)</p> <p>Priority Pollutant (EPA's Clean Water Act): Yes</p> <p>TRI-Listed Pollutant (EPA's EPCRA Section 313): Yes</p> <p>Reportable Pollutant (EPA's CERCLA's Section 304): Yes</p> <p>Source: (EPA, 2014) (EPA, 2016) (EPA, 2015)</p>	Aquatic Life Water Quality Criteria	Aquatic Life Water Quality Guidance Values	Human Health Water Quality Criteria	Freshwater, Chronic (µg/L)	Freshwater, Chronic (µg/L)	Water + Organism (µg/L)	n/a	n/a	0.000029
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n/a	n/a	0.000029								
Abbreviations / Acronyms	<p>atm·m<sup>3</sup>/mol – atmosphere-cubic meters per mole</p> <p>CASRN – Chemical Abstract Registry Number</p> <p>CERCLA – Comprehensive Environmental Response, Compensation and Liability Act</p> <p>°C – degrees Celsius</p> <p>EPA – Environmental Protection Agency</p> <p>EPCRA – Environmental Planning and Community Right-to-Know Act</p> <p>g/cm<sup>3</sup> – grams per centimeter cubed</p> <p>IUPAC – International Union of Pure and Applied Chemistry</p> <p>L/kg – liters per kilogram</p> <p>log – log base 10 of K (i.e., 10<sup>K</sup>)</p>									

	<p>mmHg – millimeters mercury</p> <p>mol/L – moles per liter</p> <p>n/a – not available / not analyzed</p> <p>µg/liter – micrograms per liter</p>
References	<p>ATSDR. (2015). Toxicological Profile for Hexachlorobenzene. <a href="https://doi.org/http://dx.doi.org/10.1155/2013/286524">https://doi.org/http://dx.doi.org/10.1155/2013/286524</a></p> <p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p> <p>EPA. (1990). National Pesticide Survey Hexachlorobenzene. Retrieved from <a href="https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=10003H0L.txt">https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=10003H0L.txt</a></p> <p>EPA. (2014). Priority Pollutant List. Retrieved from <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a></p> <p>EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <a href="https://www.epa.gov/epcra/epcracerclacaa-ss112r-consolidated-list-lists-march-2015-version">https://www.epa.gov/epcra/epcracerclacaa-ss112r-consolidated-list-lists-march-2015-version</a></p> <p>EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from <a href="https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf">https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf</a></p> <p>EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <a href="https://comptox.epa.gov/dashboard">https://comptox.epa.gov/dashboard</a></p> <p>EPA. (2018). Estimation Programs Interface Suite. Retrieved from <a href="https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface#cite">https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface#cite</a></p> <p>SRC. (2013). FatePointers Search Module, PhysProp. Retrieved December 1, 2017, from <a href="http://esc.srcinc.com/fatepointer/search.asp">http://esc.srcinc.com/fatepointer/search.asp</a></p>

<p>Profile</p>	<div> <div>Classification: Metal</div> <div>CASRN: 7439-89-6</div> <div>Molecular Formula: Fe</div> <div>IUPAC Name: Iron</div> <div>Synonyms: none</div> <div>Source: (EPA, 2017)</div> </div> <div> <div>Description</div> <div>Iron occurs naturally in the environment as a metal ore in various oxidation states (+2 and +3). Iron exists as the element and as compounds, such as iron oxide. Iron is found as a silvery-white or gray metal extracted from the earth via mining. Iron is stable in dry air but can oxidize readily in wet air. Iron is rarely found in its natural state attributed to its high reactivity.</div> <div>Chemical Characteristics</div> <table border="1"> <tr><td>Molecular Weight (g/mol)</td><td>56</td></tr> <tr><td>Density (g/cm<sup>3</sup>)</td><td>n/a</td></tr> <tr><td>Water Solubility (mg/L)</td><td>623,500 @ 25°C</td></tr> <tr><td>Boiling Point (°C)</td><td>n/a</td></tr> <tr><td>Melting Point (°C)</td><td>n/a</td></tr> <tr><td>Octanol-water partitioning coefficient (log K<sub>ow</sub>)</td><td>-0.770</td></tr> <tr><td>Octanol-air partitioning coefficient (log K<sub>oa</sub>)</td><td>-0.771</td></tr> <tr><td>Organic carbon-water partitioning coefficient (log K<sub>oc</sub>)</td><td>-0.669</td></tr> <tr><td>Vapor Pressure (mmHg)</td><td>4.24x10<sup>-9</sup> @ 25°C</td></tr> <tr><td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td>0.0245</td></tr> </table> <div>Source: (EPA, 2018; SRC, 2013)</div> <div>Organic Solvents</div> <div>Soluble in dilute acids.</div> <div>Source: (NLM, 2017)</div> </div>	Molecular Weight (g/mol)	56	Density (g/cm <sup>3</sup> )	n/a	Water Solubility (mg/L)	623,500 @ 25°C	Boiling Point (°C)	n/a	Melting Point (°C)	n/a	Octanol-water partitioning coefficient (log K <sub>ow</sub> )	-0.770	Octanol-air partitioning coefficient (log K <sub>oa</sub> )	-0.771	Organic carbon-water partitioning coefficient (log K <sub>oc</sub> )	-0.669	Vapor Pressure (mmHg)	4.24x10 <sup>-9</sup> @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	0.0245
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Henry's Law Constant (atm-m <sup>3</sup> /mol)	0.0245																				
<p>Sources</p>	<div>Natural Sources</div> <ul style="list-style-type: none"> <li>Minerals / mineral waters</li> <li>Natural weathering of soil and rocks (iron ore)</li> <li>Plants and animals (in blood) (iron oxides, inorganic/organic salts, organic omplexes)</li> </ul> <div>Non-natural Sources &amp; Uses:</div> <ul style="list-style-type: none"> <li>Metallurgy</li> <li>Catalyst in chemical manufacturing</li> <li>Vitamin supplement</li> <li>Aluminum alloy / alloy steel manufacturing</li> <li>Automotive components (including brake pads)</li> <li>Battery manufacturing</li> <li>Catalyst</li> <li>Fillers</li> </ul>																				

	<ul style="list-style-type: none"> <li>• Fuels and fuel additives</li> <li>• Laboratory chemicals</li> <li>• Paint additives</li> <li>• Plating and surface treating agents</li> <li>• Water filtration</li> <li>• Aerospace components</li> <li>• Electrical and electronic products</li> <li>• Ink, toner, and colors</li> <li>• Soil treatment</li> <li>• Secondary metal production</li> <li>• Playground and sporting equipment</li> <li>• Agriculture applications</li> <li>• Iron cookware</li> </ul> <p><b>Releases to Air</b> Releases of iron to air can occur from stack air emissions from various industrial facilities (including iron and steel manufacturing, pulp and paper mills, among others), biomass burning, vehicle exhausts, residential fireplace burning, cigarette smoke, and many other sources.</p> <p><b>Releases to Soil</b> Releases of iron to soil can occur from agricultural applications, sewage sludge, industrial facilities (manufacturing, steel, etc), stormwater runoff, acid mine drainage, incinerator ash deposits, and atmospheric deposition.</p> <p><b>Releases to Water</b> Releases of iron to surface waters can occur from wastewater treatment plants, industrial facilities (manufacturing, steel, etc), stormwater runoff, acid mine drainage, incinerator ash deposits, and atmospheric deposition.</p> <p><u>Source:</u> (NLM, 2017)</p>
<p><b>Transport and Fate</b></p>	<p><b>Transformation &amp; Degradation</b> Iron exists in the iron II and iron III oxidation states in most compounds, with iron III most likely to exist under most environmental conditions. Iron reactions depend on various environmental factors such as pH, redox potential, and ligand availability. Iron II and III form strong complexes with fulvic acid. Iron II oxide is rapidly oxidized in air forming hydrated iron III oxide (rust).</p> <p><b>Partitioning</b> The transport and partitioning of iron is dependent on the speciation complex and the environmental media.</p> <ul style="list-style-type: none"> <li>• In air, iron exists primarily in particulate matter or adsorbed to particulate matter. Iron particles can be transported long distances and undergo dry/wet atmospheric deposition depending on the particle size and location.</li> <li>• In water, iron is sorbed to organic matter. In solution, iron III hydrolyzes or forms complexes, depending on pH levels. Iron compounds (salts) do not volatilize from surface waters. Iron is found in groundwater.</li> <li>• In soil, iron sorption depends on the soil organic matter pH levels: soil sorption increases as soil organic matter and/or pH increases. Iron's mobility in soil depends on its redox</li> </ul>



	<p>potential: mobility increases under reducing conditions versus oxidizing. Iron compounds (salts) do not volatilize from soil surfaces.</p> <p>Bioaccumulation/Bioconcentration</p> <p>Bioconcentration potential of iron is high as it is an essential element for humans and aquatic life and found naturally in humans, plants, and aquatic species. No information is available on bioaccumulation.</p> <p>Source: (NLM, 2017)</p>						
Water Quality Regulations	<p>Oregon Water Quality Standards</p> <table><tr><th>Aquatic Life Water Quality Criteria Freshwater, Chronic (µg/L)</th><th>Aquatic Life Water Quality Guidance Values Freshwater, Chronic (µg/L)</th><th>Human Health Water Quality Criteria Water + Organism (µg/L)</th></tr><tr><td>Calculated as function of hardness</td><td>n/a</td><td>n/a</td></tr></table> <p>Source: (DEQ, 2017)</p> <p>Priority Pollutant (EPA's Clean Water Act): No</p> <p>TRI-Listed Pollutant (EPA's EPCRA Section 313): No</p> <p>Reportable Pollutant (EPA's CERCLA's Section 304): No</p> <p>Sources: (EPA, 2014, 2015, 2016)</p>	Aquatic Life Water Quality Criteria Freshwater, Chronic (µg/L)	Aquatic Life Water Quality Guidance Values Freshwater, Chronic (µg/L)	Human Health Water Quality Criteria Water + Organism (µg/L)	Calculated as function of hardness	n/a	n/a
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References	<p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p> <p>EPA. (2014). Priority Pollutant List. Retrieved from <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-</a></p>						

	<p>epa.pdf</p> <p>EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <a href="https://www.epa.gov/epcra/epcracerclaaa-ss112r-consolidated-list-lists-march-2015-version">https://www.epa.gov/epcra/epcracerclaaa-ss112r-consolidated-list-lists-march-2015-version</a></p> <p>EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from <a href="https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf">https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf</a></p> <p>EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <a href="https://comptox.epa.gov/dashboard">https://comptox.epa.gov/dashboard</a></p> <p>EPA. (2018). Estimation Programs Interface Suite. Retrieved from <a href="https://www.epa.gov/tsca-screening-tools/epi-suite-tm-estimation-program-interface# citing">https://www.epa.gov/tsca-screening-tools/epi-suite-tm-estimation-program-interface# citing</a></p> <p>NLM. (2017). TOXNET. Retrieved November 1, 2017, from <a href="https://toxnet.nlm.nih.gov/">https://toxnet.nlm.nih.gov/</a></p> <p>SRC. (2013). FatePointers Search Module, PhysProp. Retrieved December 1, 2017, from <a href="http://esc.srcinc.com/fatepointer/search.asp">http://esc.srcinc.com/fatepointer/search.asp</a></p>
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<p>Profile</p>	<div style="text-align: right; font-size: 48pt; font-weight: bold;">Pb</div> <p>Classification: Metal</p> <p>CASRN: 7439-92-1</p> <p>Molecular Formula: Pb</p> <p>IUPAC Name: Lead</p> <p>Synonyms: none</p> <p><u>Source:</u> (EPA, 2017)</p> <p><b>Description</b> Lead occurs naturally in the environment as a metal ore in various oxidation states (0, II, and IV) but primarily as lead (II). Lead exists as compounds with two or more other elements. Lead is found as a blue/grey metal that is extracted from the earth via mining. Primary lead is obtained from mining and secondary lead is obtained from scrap.</p> <p><b>Chemical Characteristics</b></p> <table border="1"> <tbody> <tr> <td>Molecular Weight (g/mol)</td><td>207</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>n/a</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>9,573 @ 25°C</td></tr> <tr> <td>Boiling Point (°C)</td><td>1,740</td></tr> <tr> <td>Melting Point (°C)</td><td>327</td></tr> <tr> <td>Octanol-water partitioning coefficient (log K<sub>ow</sub>)</td><td>0.730</td></tr> <tr> <td>Octanol-air partitioning coefficient (log K<sub>oa</sub>)</td><td>0.729</td></tr> <tr> <td>Organic carbon-water partitioning coefficient (log K<sub>oc</sub>)</td><td>0.633</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td>1.77 @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td>0.0245 @ 25°C</td></tr> </tbody> </table> <p><u>Source:</u> (ATSDR, 2007; EPA, 2017, 2018)</p> <p><b>Organic Solvents</b> Insoluble in organic solvents and water.</p> <p><u>Source:</u> (ATSDR, 2007; NLM, 2017)</p>	Molecular Weight (g/mol)	207	Density (g/cm <sup>3</sup> )	n/a	Water Solubility (mg/L)	9,573 @ 25°C	Boiling Point (°C)	1,740	Melting Point (°C)	327	Octanol-water partitioning coefficient (log K <sub>ow</sub> )	0.730	Octanol-air partitioning coefficient (log K <sub>oa</sub> )	0.729	Organic carbon-water partitioning coefficient (log K <sub>oc</sub> )	0.633	Vapor Pressure (mmHg)	1.77 @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	0.0245 @ 25°C
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<p>Sources</p>	<p><b>Natural Sources</b></p> <ul style="list-style-type: none"> <li>Natural weathering of lead-bearing rocks and soil</li> </ul> <p><b>Non-natural Sources &amp; Uses:</b></p> <ul style="list-style-type: none"> <li>Mines producing lead</li> <li>Batteries</li> <li>Lead alloys in bearings, brass/bronze, and solders</li> <li>Sheets and pipe for nuclear and x-ray shielding</li> <li>Cable coverings</li> <li>Noise control materials</li> <li>Chemical resistant linings</li> <li>Ammunition</li> <li>Pigment</li> <li>Compounds in glass and ceramic glazes</li> </ul>																				

	<ul style="list-style-type: none"> <li>• Stabilizers and caulk</li> <li>• Leaded gasoline</li> <li>• Agricultural (fungicides, herbicides, rodenticides, insecticides – prior to 1960s)</li> <li>• Various other uses of lead compounds</li> </ul> <p>Releases to Air Emissions of lead are reported from production processes and consumptive use, including metal processing, smelters, battery manufacturing, chemical manufacturing, mobile sources involving use of gasoline (automotive and other transportation), waste incineration, electric utility steam generating plants, and lead-based paints.</p> <p>Releases to Soil Releases of lead to soil are reported from production processes and consumptive use, including underground injection, solid wastes from metal/coal mining, electrical utilities, solid paint releases (chips and dust), releases from hazardous waste sites, and leaching from landfills. Natural sources include atmospheric deposition.</p> <p>Releases to Water Releases of lead to surface waters are reported from production processes and consumptive use, primarily from wastewater effluent associated with iron industries and lead production/processing, urban stormwater runoff, lead shot and sinkers at shooting ranges, leaching from water systems, leaching from household plumbing, releases from hazardous waste sites and leaching from landfills. Natural sources include atmospheric deposition and land erosion.</p> <p><u>Source:</u> (ATSDR, 2007)</p>
Transport and Fate	<p>Transformation &amp; Degradation Lead is found in various states dependent on the conditions of environmental media and presence of other complex ions.</p> <ul style="list-style-type: none"> <li>• In air, lead is emitted in varying states dependent on the process (i.e., mining, smelting, fuel combustion). Lead is primarily found in the atmosphere as lead sulfate and lead carbonate. Fuel combustion results in lead being present mostly in the vapor phase. Lead transformations are by direct photolysis, reaction with hydroxyl radicals, and ozone.</li> <li>• In water, lead is found in varying forms given the complexity of the compound and processes that occur. Lead is generally found in compounds with low solubility and forms complexes with humic acid and organic matter. Adsorption increases with pH and decreases with increased water hardness. The amount of lead dissolved in water is dependent on the pH and dissolved salt content. In fresh water, lead is found as the divalent cation (lead II) at pH&lt;7.5. In sea water, lead is found as lead chloride and lead carbonate. Certain lead compounds can undergo photolysis and hydrolysis.</li> <li>• In soil, lead is found as lead sulfates and lead carbonate from atmospheric deposition. Additional lead reactions occur in soil and the speciated form of lead is depended on soil properties. Lead is transformed by biological and chemical processes to adsorbed forms through formation of lead complexes on clay materials, humic acid, and organic matter. Soil adsorption is dependent on pH and cation exchange capacity (more soluble as pH increases to 5, sparingly soluble at pH &gt;8).</li> </ul> <p>Partitioning The transport and partitioning of lead is dependent on the speciation complex and the</p>

	<p>environmental media.</p> <ul style="list-style-type: none"><li>• In air, lead exists primarily in particulate matter or adsorbed to particulate matter, dependent on the particle size. Copper particles can be transported long distances and undergo dry/wet atmospheric deposition depending on the particle size and location.</li><li>• In water, lead in soluble form depends on the pH and dissolved salt content of the water. The majority of lead in rivers is in undissolved form containing larger undissolved particulates (lead carbonate, lead oxide, lead hydroxide, or others). Lead can be either sorbed ions or surface coatings on sediment mineral particles, or carried by suspended organic matter in water. Lead is primarily found in suspended solids versus dissolved form.</li><li>• In soil, lead sorbs strongly to particulates and solid matter unless in acidic conditions. Lead's adsorptive capacity is dependent on lead concentration, pH, soil type, particle size, cation exchange capacity, and organic matter content. At low pH, dissolved lead in ionic form (lead II) and ion pairs (lead sulfate) have been reported as predominant species. Mobility of lead in soil and leaching of lead to groundwater is limited but can enter surface water through erosion of lead-containing soils. Mobility of lead increases in low pH conditions (lead solubility is enhanced in acidic conditions).</li></ul> <p>Bioaccumulation/Bioconcentration</p> <p>Lead bioconcentrates and bioaccumulates in plants and aquatic organisms at varying degrees.</p> <p>Source: (ATSDR, 2007)</p>						
Water Quality Regulations	<p>Oregon Water Quality Standards</p> <table><tr><th>Aquatic Life Water Quality Criteria Freshwater, Chronic (µg/L)</th><th>Aquatic Life Water Quality Guidance Values Freshwater, Chronic (µg/L)</th><th>Human Health Water Quality Criteria Water + Organism (µg/L)</th></tr><tr><td>Calculated as function of hardness</td><td>n/a</td><td>n/a</td></tr></table> <p>Source: (DEQ, 2017)</p> <p>Priority Pollutant (EPA's Clean Water Act): No</p> <p>TRI-Listed Pollutant (EPA's EPCRA Section 313): No</p> <p>Reportable Pollutant (EPA's CERCLA's Section 304): No</p> <p>Source: (EPA, 2014, 2015, 2016)</p>	Aquatic Life Water Quality Criteria Freshwater, Chronic (µg/L)	Aquatic Life Water Quality Guidance Values Freshwater, Chronic (µg/L)	Human Health Water Quality Criteria Water + Organism (µg/L)	Calculated as function of hardness	n/a	n/a
Aquatic Life Water Quality Criteria Freshwater, Chronic (µg/L)	Aquatic Life Water Quality Guidance Values Freshwater, Chronic (µg/L)	Human Health Water Quality Criteria Water + Organism (µg/L)					
Calculated as function of hardness	n/a	n/a					
Abbreviations / Acronyms	<p>atm-m<sup>3</sup>/mol – atmosphere-cubic meters per mole</p> <p>CASRN – Chemical Abstract Registry Number</p> <p>CERCLA – Comprehensive Environmental Response, Compensation and Liability Act</p> <p>°C – degrees Celsius</p> <p>EPA – Environmental Protection Agency</p> <p>EPCRA – Environmental Planning and Community Right-to-Know Act</p> <p>g/cm<sup>3</sup> – grams per centimeter cubed</p> <p>IUPAC – International Union of Pure and Applied Chemistry</p>						

	<p>L/kg – liters per kilogram</p> <p>log – log base 10 of K (i.e., 10<sup>K</sup>)</p> <p>mm Hg – millimeters mercury</p> <p>mol/L – moles per liter</p> <p>n/a – not available / not analyzed</p> <p>µg/liter – micrograms per liter</p>
References	<p>ATSDR. (2007). Toxicological Profile for Lead. <a href="https://doi.org/doi:10.1201/9781420061888_ch106">https://doi.org/doi:10.1201/9781420061888_ch106</a></p> <p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p> <p>EPA. (2014). Priority Pollutant List. Retrieved from <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a></p> <p>EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <a href="https://www.epa.gov/epcra/epcracerclacaa-ss112r-consolidated-list-lists-march-2015-version">https://www.epa.gov/epcra/epcracerclacaa-ss112r-consolidated-list-lists-march-2015-version</a></p> <p>EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from <a href="https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf">https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf</a></p> <p>EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <a href="https://comptox.epa.gov/dashboard">https://comptox.epa.gov/dashboard</a></p> <p>EPA. (2018). Estimation Programs Interface Suite. Retrieved from <a href="https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface# citing">https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface# citing</a></p> <p>NLM. (2017). PubChem Substance and Compound Databases. Retrieved November 1, 2017, from <a href="https://pubchem.ncbi.nlm.nih.gov/">https://pubchem.ncbi.nlm.nih.gov/</a></p>

Hg

<p>Profile</p>	<p>Classification: Metal</p> <p>CASRN: 7439-97-6</p> <p>Molecular Formula: Hg</p> <p>IUPAC Name: Mercury</p> <p>Synonyms: none</p> <p>Source: (EPA, 2017)</p> <p>Description</p> <p>Mercury occurs naturally in the environment as a metal ore in various forms (metallic [elemental], inorganic, and organic). Several mercury compounds are found naturally in the environment (such as methylmercury). Mercury is found as a silvery-white shiny metal that exists as a liquid at room temperature and does not combine with other elements. Inorganic mercury combines with chlorine, sulfur, or oxygen (i.e., mercury salts). Organic mercury combines with carbon (methylmercury). Mercury is mined as cinnabar ore (mercuric sulfide).</p> <p>Chemical Characteristics</p> <table border="1"> <tr> <td>Molecular Weight (g/mol)</td><td>201</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>n/a</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>0.060 @ 25°C</td></tr> <tr> <td>Boiling Point (°C)</td><td>357</td></tr> <tr> <td>Melting Point (°C)</td><td>-39</td></tr> <tr> <td>Octanol-water partitioning coefficient (log K<sub>ow</sub>)</td><td>0.620</td></tr> <tr> <td>Octanol-air partitioning coefficient (log K<sub>oa</sub>)</td><td>1.07</td></tr> <tr> <td>Organic carbon-water partitioning coefficient (log K<sub>oc</sub>)</td><td>0.538</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td>0.00200 @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm·m<sup>3</sup>/mol)</td><td>0.00862 @ 25°</td></tr> </table> <p>Source: (ATSDR, 1999; EPA, 2018; SRC, 2013)</p> <p>Organic Solvents</p> <p>Soluble in alcohol and acetic acid. Soluble in water (varying temperatures).</p> <p>Source: (ATSDR, 1999; NLM, 2017)</p>	Molecular Weight (g/mol)	201	Density (g/cm <sup>3</sup> )	n/a	Water Solubility (mg/L)	0.060 @ 25°C	Boiling Point (°C)	357	Melting Point (°C)	-39	Octanol-water partitioning coefficient (log K <sub>ow</sub> )	0.620	Octanol-air partitioning coefficient (log K <sub>oa</sub> )	1.07	Organic carbon-water partitioning coefficient (log K <sub>oc</sub> )	0.538	Vapor Pressure (mmHg)	0.00200 @ 25°C	Henry's Law Constant (atm·m <sup>3</sup> /mol)	0.00862 @ 25°
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<p>Sources</p>	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>Natural weathering of metallic mercury-bearing rocks and soil</li> </ul> <p>Non-natural Sources &amp; Uses:</p> <ul style="list-style-type: none"> <li>Mines producing metallic mercury</li> <li>Mercury product recycling</li> <li>Dental amalgams and supplies</li> <li>Switches, measurement (calibration) devices, wiring, and thermostats</li> <li>Wastewater sludge</li> <li>Chemical solutions</li> <li>Fluorescent light tubes (and mercury vapors in electrical lamps)</li> <li>Batteries (alkaline)</li> </ul>																				

	<ul style="list-style-type: none"> <li>• Pharmaceutical and beauty products</li> <li>• Paint pigments, inks, caulking compounds</li> <li>• Catalyst to form polymers (vinyl chloride and urethane foams)</li> </ul> <p><b>Releases to Air</b> Emissions of mercury are reported from production processes and consumptive use, including mining/smelting, industrial manufacturing processes, waste incineration (industrial and municipal), fossil fuel combustion (coal), cement production, commercial/industrial boilers, sludge applied to crops, and fires at waste disposal sites. Natural sources include emissions from terrestrial and marine systems recycled from anthropogenic sources.</p> <p><b>Releases to Soil</b> Releases of mercury to soil are reported from production processes and consumptive use, including underground injection, agricultural (fertilizer application), residential yard compost, application of sludge wastes, releases from hazardous waste sites, and leaching from landfills. Natural sources include atmospheric deposition and soil erosion.</p> <p><b>Releases to Water</b> Releases of mercury to surface waters are reported from production processes and consumptive use, including urban stormwater runoff, industrial wastewater effluent, mining operations and ore processing, metallurgy and electroplating, chemical manufacturing, pulp and paper mills, leather tanning, pharmaceutical production, ink manufacturing, and textile manufacturing, wastewater treatment plants (industrial/municipal), runoff from agricultural fertilizer application, releases from hazardous waste sites, and leaching from landfills. Natural sources include atmospheric deposition and land erosion, in addition to natural weathering of rocks.</p> <p><u>Source:</u> (ATSDR, 1999)</p>
<p><b>Transport and Fate</b></p>	<p><b>Transformation &amp; Degradation</b> Mercury is found in various states dependent on the conditions of environmental media and presence of other complex ions. Mercury is able to transform by bioatic and abiotic oxidation and reduction reactions and other processes.</p> <ul style="list-style-type: none"> <li>• In air, mercury exists primarily in the vapor phase as metallic mercury (elemental mercury) and is oxidized by ozone to mercury (II). Oxidation and reduction also occurs in the present of radicals. Mercuric hydroxide is found in the aqueous phase in the atmosphere and is rapidly reduced to monovalent mercury in sunlight. Photolysis is the primary process for organomercurials.</li> <li>• In water, mercury is transformed primarily by biotransformation. Photolysis may occur but may be insignificant. Mercury in any form can be transformed microbially to methylmercury ions in anaerobic conditions. The rate is controlled by varying factors including concentrations and oxygen content of the water. Methylated mercury in water is reduced as dissolved organic carbon content increases. Methylated mercury in water increases as pH decreases (and mercury concentrations in sediment are high). Mercuric sulfide has limited water solubility.</li> <li>• In soil, mercury undergoes similar transformations as in water and requiring similar conditions. Mercury forms complexes with chloride and hydroxide ions dependent on pH, salt content, and soil properties. Methyl mercury concentrations reduce in soil in the presence of increased chlorine ions. Methyl mercury concentrations in sediment increase with increasing organic carbon content. Mercuric sulfide has limited water solubility and</li> </ul>



thus, limited mobility in soil. Aerobic microorganisms can reduce mercury (II) to elemental mercury.

## Partitioning

The transport and partitioning of mercury is dependent on the speciation complex and the environmental media.

- In air, mercury exists primarily (95%) as a gas (elemental mercury, Hg<sup>0</sup>) with the remaining amount (5%) associated with particulate matter. Mercury particles can be transported long distances and undergo dry/wet atmospheric deposition depending on the particle size and location.
- In water, mercury exists as mercuric (Hg (II)) and mercurous (Hg (I)) and has varying water solubility. Mercuric is the most predominant form in water. Volatile forms of metallic mercury and dimethylmercury evaporate readily and solid forms sorb to particulates in the water column or sediment. Methylmercury is strongly sorbed to organic matter and is dependent on pH (>4). Methylmercury is highly soluble and thus mobile.
- In soil, mercury exists as mercuric (Hg (II)) and mercurous (Hg (I)). Mercury adsorption in soil decreases with increasing pH and/or chloride ion concentration. Mercury adsorption in soil increases with high iron and aluminum content. Inorganic mercury sorbed to particulates is not readily desorbed. Mercury volatilizes from acidic soils (pH <3). Leaching of mercury is insignificant. Surface water runoff is an important process for transporting mercury in soil to water. Methylmercury is mobile and leaches in soil.

## Bioaccumulation/Bioconcentration

Mercury bioaccumulates in the terrestrial food chain. Methylmercury biomagnifies in the aquatic food chain more rapidly than other forms of mercury. Fish and other aquatic organisms bioaccumulate methylmercury from food and the water column.

Bioconcentration Factor	Bioaccumulation Factor
Freshwater species: 1,800 to 81,670	n/a
Saltwater species: 129 to 40,000	

### Notes:

BCF reported for mercury II and organomercury compounds

BCF reported for fish

Source: (ATSDR, 1999)

## Water Quality Regulations

### Oregon Water Quality Standards

Aquatic Life Water Quality Criteria	Aquatic Life Water Quality Guidance Values	Human Health Water Quality Criteria
Freshwater, Chronic (µg/L)	Freshwater, Chronic (µg/L)	Water + Organism (µg/L)
0.012	n/a	n/a

Source: (DEQ, 2017)

Priority Pollutant (EPA's Clean Water Act): Yes

TRI-Listed Pollutant (EPA's EPCRA Section 313): Yes

Reportable Pollutant (EPA's CERCLA's Section 304): Yes

Source: (EPA, 2014, 2015, 2016)

Abbreviations / Acronyms	<p>atm-m<sup>3</sup>/mol – atmosphere-cubic meters per mole</p> <p>CASRN – Chemical Abstract Registry Number</p> <p>CERCLA – Comprehensive Environmental Response, Compensation and Liability Act</p> <p>°C – degrees Celsius</p> <p>EPA – Environmental Protection Agency</p> <p>EPCRA – Environmental Planning and Community Right-to-Know Act</p> <p>g/cm<sup>3</sup> – grams per centimeter cubed</p> <p>IUPAC – International Union of Pure and Applied Chemistry</p> <p>L/kg – liters per kilogram</p> <p>log – log base 10 of K (i.e., 10<sup>K</sup>)</p> <p>mm Hg – millimeters mercury</p> <p>mol/L – moles per liter</p> <p>n/a – not available / not analyzed</p> <p>µg/liter – micrograms per liter</p>
References	<p>ATSDR. (1999). Toxicological Profile for Mercury. <a href="https://doi.org/10.1201/9781420061888_ch109">https://doi.org/10.1201/9781420061888_ch109</a></p> <p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p> <p>EPA. (2014). Priority Pollutant List. Retrieved from <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a></p> <p>EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <a href="https://www.epa.gov/epcra/epcracerclaa-ss112r-consolidated-list-lists-march-2015-version">https://www.epa.gov/epcra/epcracerclaa-ss112r-consolidated-list-lists-march-2015-version</a></p> <p>EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from <a href="https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RX_2016_RFI.pdf">https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RX_2016_RFI.pdf</a></p> <p>EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <a href="https://comptox.epa.gov/dashboard">https://comptox.epa.gov/dashboard</a></p> <p>EPA. (2018). Estimation Programs Interface Suite. Retrieved from <a href="https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface#citing">https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface#citing</a></p> <p>NLM. (2017). PubChem Substance and Compound Databases. Retrieved November 1, 2017, from <a href="https://pubchem.ncbi.nlm.nih.gov/">https://pubchem.ncbi.nlm.nih.gov/</a></p> <p>SRC. (2013). FatePointers Search Module, PhysProp. Retrieved December 1, 2017, from <a href="http://esc.srcinc.com/fatepointer/search.asp">http://esc.srcinc.com/fatepointer/search.asp</a></p>

# Toxic Pollutant Profile | Polycyclic Aromatic Hydrocarbons (PAHs)

## Profile

Classification: Polycyclic Aromatic Hydrocarbons (PAHs)

CASRN: varies

Molecular Formula:  $C_{10-22}H_{8-14}$

IUPAC Name: varies

Synonyms: n/a

Source: (EPA, 2017)

### Description

PAHs are aromatic hydrocarbons with two or more (up to 6) fused benzene rings that exist as colorless, white, or pale yellow-green solids, and that can occur naturally or be man-made. PAHs are complex mixtures consisting of primarily 18 individual compounds.

### Chemical Characteristics

Molecular Weight (g/mol)	154 - 278
Density (g/cm <sup>3</sup> )	1.03 - 1.38 @ 25°C
Water Solubility (mg/L)	2.60E <sup>-4</sup> to 31 @ 25°C
Boiling Point (°C)	218 to 536
Melting Point (°C)	80 to 278
Octanol-water partitioning coefficient (log K <sub>ow</sub> )	3.30 to 6.75 → Hydrophobic
Octanol-air partitioning coefficient (log K <sub>oa</sub> )	5.05 to 11.99
Organic carbon-water partitioning coefficient (log K <sub>oc</sub> )	1.40 to 6.74
Vapor Pressure (mmHg)	9.59x10 <sup>-11</sup> to 0.085 @ 25°C
Henry's Law Constant (atm·m <sup>3</sup> /mol)	7.30x10 <sup>-8</sup> to 1.45E <sup>-3</sup> @ 25°C

Source (ATSDR, 1996; EPA, 2018; SRC, 2013)

### Organic Solvents

Some PAH compounds are miscible (or only slightly miscible) with various substances, including: alcohol, methanol, propanol, chloroform, benzene, toluene, acetic acid, acetone, carbon disulphide, carbon tetrachloride, and organic solvents.

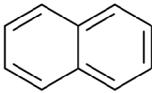
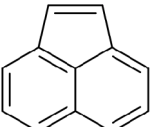
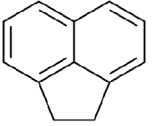
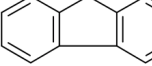
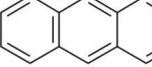
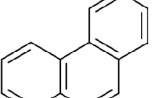
\*The chemical characteristics for each PAH constituent are identified on the following pages\*

# Toxic Pollutant Profile | Polycyclic Aromatic Hydrocarbons (PAHs)

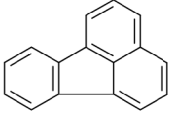
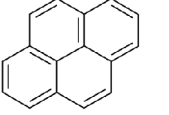
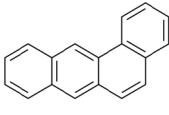
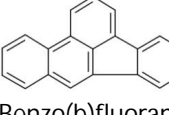
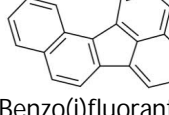
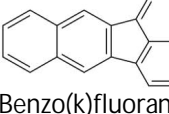
Characteristic	Low Molecular Weight	Medium Molecular Weight	High Molecular Weight
Molecular Weight (g/mol)	152 – 178	202	228 – 278
Henry's Law Constant (atm-m <sup>3</sup> /mol)	10 <sup>-3</sup> – 10 <sup>-5</sup> (significant volatilization)	10 <sup>-6</sup>	10 <sup>-5</sup> – 10 <sup>-8</sup> (lesser extent of volatilization)
Soil organic carbon-water coefficient (K <sub>oc</sub> )	10 <sup>3</sup> – 10 <sup>4</sup> (moderate sorption tendency)	10 <sup>4</sup>	10 <sup>5</sup> – 10 <sup>6</sup> (stronger sorption tendency)
Total Benzene Rings	2 to 3	4	4 to 6
Pollutant	Acenaphthene (2 rings) Acenaphthylene (2 rings) Fluorene (2 rings) Anthracene (3 rings) Phenanthrene (3 rings)	Fluoranthene (4 rings) Pyrene (4 rings)	Benzo(a)anthracene (4 rings) Benzo(b)fluoranthene (4 rings) Benzo(j)fluoranthene (4 rings) Benzo(k)fluoranthene (4 rings) Chrysene (4 rings) Dibenzo(a,h)anthracene (5 rings) Indeno(1,2,3-cd)pyrene (5 rings) Benzo(a)pyrene (5 rings) Benzo(e)pyrene (5 rings) Benzo(g,h,i)perylene (6 rings)

Source: (ATSDR, 1996; EPA, 2008; NLM, 2017; Potter & Simmons, 1998)


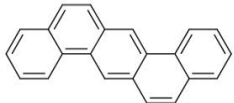
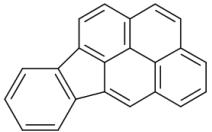
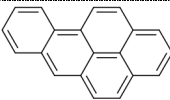
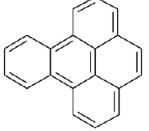
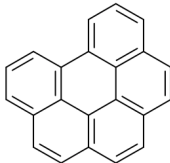
# Toxic Pollutant Profile | Polycyclic Aromatic Hydrocarbons (PAHs)

Profile	Chemical Characteristics										
	Toxic Pollutant	Molecular Weight (g/mol)	Density (g/cm <sup>3</sup> )	Water Solubility (mg/L)	Boiling Point (°C)	Melting Point (°C)	Octanol-water coefficient (log K <sub>ow</sub> )	Octanol-air coefficient (log K <sub>oa</sub> )	Organic carbon coefficient (log K <sub>oc</sub> )	Vapor Pressure (mmHg)	Henry's Law Constant (atm·m <sup>3</sup> /mol)
	 Naphthalene	128	1.03	31	218	80	3.30	5.05	2.86	8.50E-02	4.40E-04
	Low Molecular Weight										
	 Acenaphthylene	152	1.19	16.1	280	93	3.94	6.27	3.42	8.50E-02	4.40E-04
	 Acenaphthene	154	1.13	3.90	279	93	3.92	6.31	3.40	6.68E-03	1.14E-04
	 Fluorene	166	1.12	1.69	295	115	4.18	6.59	3.63	2.15E-03	1.84E-04
	 Anthracene	178	1.13	0.434	340	215	4.45	7.09	3.86	6.00E-04	9.62E-05
	 Phenanthrene	178	1.13	1.15	340	99	4.46	7.22	3.87	1.21E-04	4.23E-05

# Toxic Pollutant Profile | Polycyclic Aromatic Hydrocarbons (PAHs)

Profile	Toxic Pollutant	Molecular Weight (g/mol)	Density (g/cm <sup>3</sup> )	Water Solubility (mg/L)	Boiling Point (°C)	Melting Point (°C)	Octanol-water coefficient (log K <sub>ow</sub> )	Octanol-air coefficient (log K <sub>oa</sub> )	Organic carbon coefficient (log K <sub>oc</sub> )	Vapor Pressure (mmHg)	Henry's Law Constant (atm·m <sup>3</sup> /mol)
	Medium Molecular Weight										
	 Fluoranthene	202	1.25	0.260	384	108	5.16	8.60	4.48	9.22E-06	8.86E-06
	 Pyrene	202	1.25	0.135	404	151	4.88	8.19	4.24	4.50E-06	1.19E-05
	High Molecular Weight										
	 Benzo(a)anthracene	228	1.19	0.0094	438	84	5.76	9.07	5.00	2.10E-07	1.20E-05
	 Benzo(b)fluoranthene	252	1.29	0.0011	--	168	5.78	10.35	5.02	5.00E-07	6.57E-07
	 Benzo(j)fluoranthene	252	1.28	0.0025	--	166	6.11	10.59	5.30	1.50E-08	1.00E-06
	 Benzo(k)fluoranthene	252	1.29	0.0008	480	217	6.11	10.73	5.30	9.65E-10	5.84E-07

# Toxic Pollutant Profile **Polycyclic Aromatic Hydrocarbons (PAHs)**

Profile	Toxic Pollutant	Molecular Weight (g/mol)	Density (g/cm <sup>3</sup> )	Water Solubility (mg/L)	Boiling Point (°C)	Melting Point (°C)	Octanol-water coefficient (log K <sub>ow</sub> )	Octanol-air coefficient (log K <sub>oa</sub> )	Organic carbon coefficient (log K <sub>oc</sub> )	Vapor Pressure (mmHg)	Henry's Law Constant (atm·m <sup>3</sup> /mol)
	 Chrysene	228	1.19	0.0020	448	258	5.81	9.48	5.04	6.23E-09	5.23E-06
	 Dibenzo(a,h)anthracene	278	1.24	0.0025	524	270	6.75	11.99	5.86	9.55E-10	7.30E-08
	 Indeno(1,2,3-cd)pyrene	276	1.38	0.0002	536	164	6.58	11.55	5.82	5.01E-09	3.48E-07
	 Benzo(a)pyrene	252	1.28	0.0016	495	177	6.13	10.86	5.32	5.49E-09	4.57E-07
	 Benzo(e)pyrene	252	1.29	0.0063	311	178	6.44	11.35	5.59	5.70E-09	1.22E-05
	 (Benzo(g,h,i)perylene	276	1.38	0.0003	500	278	6.63	11.50	5.75	1.00E-10	3.31E-07

# Toxic Pollutant Profile | Polycyclic Aromatic Hydrocarbons (PAHs)

Sources	<p><b>Natural Sources</b></p> <ul style="list-style-type: none"> <li>• Incomplete combustion of wood and fuel</li> <li>• Volcanoes and forest fires</li> <li>• Crude oil/shale oil</li> </ul> <p><b>Non-natural Sources &amp; Uses:</b></p> <ul style="list-style-type: none"> <li>• Manufacturing/processing (in the US: acenaphthene, acenaphthylene, and anthracene)</li> <li>• Research chemicals (benzo[a]anthracene, benzo[a]pyrene, benzo[e]pyrene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, chrysene, dibenzo[a,h]anthracene, indeno[1,2,3-cd]pyrene, phenanthrene, pyrene)</li> <li>• Dye and synthetic fiber production, diluent, synthesize chemotherapy agents, pharmaceutical and plastic manufacturing, and insecticide/fungicide (anthracene)</li> <li>• Chemical processes, formation of polyradicals for resins, dyestuff manufacturing (fluorene)</li> <li>• Dyestuff manufacturing and explosives in biological research (phenanthrene)</li> <li>• Lining of steel interiors (including iron drinking water pipes and storage tanks) (fluoranthene)</li> </ul> <p><b>Releases to Air</b> Emissions of PAHs to the atmosphere are reported from residential wood and plastic burning, industrial power generation, incineration, coal/tar/coke/asphalt production, petroleum catalytic cracking, tobacco smoke, space heaters, gas cooking/heating appliances, vehicle exhausts (gasoline/diesel-powered). Natural sources include forest fires and volcanoes.</p> <p><b>Releases to Soil</b> Releases of PAHs to soil are reported from public sewage treatment plants sludge disposal, vehicle exhaust, wear/tear of vehicle tires, irrigation with coke effluent, leachate from bituminous coal storage, soil compost and fertilizers, leaching from landfills, manufactured gas plants, and hazardous waste sites. Natural sources include atmospheric deposition (as a result of anthropogenic sources).</p> <p><b>Releases to Water</b> Releases of PAHs to surface waters and groundwater are reported from coal storage areas runoff, wood treatment plants effluent, petroleum processing effluent, municipal sewage effluent, urban runoff, and oil spills. Natural sources include atmospheric deposition (as a result of anthropogenic sources).</p> <p><u>Predominant PAH compositions and combustion sources:</u></p> <ul style="list-style-type: none"> <li>• Residential wood combustion – acenaphthylene</li> <li>• Gasoline exhaust – benzo(g,h,i)perylene and pyrene</li> <li>• Diesel exhaust – fluoranthene, phenanthrene, acenaphthene, anthracene, and pyrene</li> <li>• Municipal refuse incinerators – phenanthrene and benzo(g,h,i)perylene</li> <li>• Natural gas home appliances – chrysene, pyrene, and fluoranthene</li> <li>• Tobacco smoke – benzo(a)pyrene and others</li> <li>• Atmospheric deposition – benzo(a)pyrene</li> </ul> <p><u>Source:</u> (ATSDR, 1996)</p>
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# Toxic Pollutant Profile | Polycyclic Aromatic Hydrocarbons (PAHs)

Transport and Fate	<p>Transformation &amp; Degradation</p> <p>PAHs can volatilize, photolyze, oxidize, and biodegrade. The rate/extent of transformation/degradation is dependent on the molecular structures, environmental factors, and presence of other contaminants.</p> <ul style="list-style-type: none"><li>• In the atmosphere, most PAHs are associated with particulates and photolysis is the most predominant degradation method.</li><li>• In water, hydrolysis is not considered an important process. PAHs can degrade via photo-oxidation, chemical oxidation, and aquatic microorganisms.</li><li>• In soil/sediment, microbial metabolism is the primary degradation process. Hydrolysis, photolysis, and oxidation are generally not considered important.</li></ul> <p>Partitioning</p> <p>Partitioning of PAHs is dependent on each individual's physical and chemical properties. PAHs generally have low water solubility and high affinity for organic carbon. PAHs with more benzene rings tend to sorb to soil/sediment particles. PAHs with less benzene rings tend to be more volatile. The rate of atmospheric deposition depends on individual PAH structures. PAHs can enter groundwater from soil.</p> <p>General partitioning phase based on PAH chemical structure:</p> <ul style="list-style-type: none"><li>• Two to three benzene rings – exists in air predominantly in the vapor phase</li><li>• Four benzene rings – exists in the vapor and particulate phase</li><li>• Five or more benzene rings – exists predominantly in the particle phase</li></ul> <p>Bioaccumulation/Bioconcentration</p> <p>PAHs bioaccumulate in plants, aquatic organisms, and animals. However, food chain biomagnification does not appear to be significant for aquatic organisms.</p> <table><tr><th>Bioconcentration Factor</th><th>Bioaccumulation Factor</th></tr><tr><td>&lt;10 to 134,248</td><td>n/a</td></tr></table> <p>Notes:</p> <p>BCF reported as a range for all identified PAH constituents identified</p> <p>BCF reported for fish</p> <p>Source: (ATSDR, 1996)</p>	Bioconcentration Factor	Bioaccumulation Factor	<10 to 134,248	n/a																																								
	Bioconcentration Factor	Bioaccumulation Factor																																											
	<10 to 134,248	n/a																																											
	Water Quality Regulations	<p>Oregon Water Quality Standards</p> <table><tr><th rowspan="2">Toxic Pollutant</th><th>Aquatic Life Water Quality Criteria</th><th>Aquatic Life Water Quality Guidance Values</th><th>Human Health Water Quality Criteria</th></tr><tr><th>Freshwater, Chronic (µg/L)</th><th>Freshwater, Chronic (µg/L)</th><th>Water + Organism (µg/L)</th></tr><tr><td>Acenaphthene</td><td>n/a</td><td>520</td><td>95</td></tr><tr><td>Anthracene</td><td>n/a</td><td>2,900</td><td>n/a</td></tr><tr><td>Benzo(a)anthracene</td><td>n/a</td><td>n/a</td><td>0.0013</td></tr><tr><td>Benzo(a)pyrene</td><td>n/a</td><td>n/a</td><td>0.0013</td></tr><tr><td>Benzo(e)pyrene</td><td>n/a</td><td>n/a</td><td>n/a</td></tr><tr><td>Benzo(b)fluoranthene</td><td>n/a</td><td>n/a</td><td>0.0013</td></tr><tr><td>Benzo(j)fluoranthene</td><td>n/a</td><td>n/a</td><td>n/a</td></tr><tr><td>Benzo(k)fluoranthene</td><td>n/a</td><td>n/a</td><td>0.0013</td></tr><tr><td>Benzo(g,h,i)perylene</td><td>n/a</td><td>n/a</td><td>n/a</td></tr></table>	Toxic Pollutant	Aquatic Life Water Quality Criteria	Aquatic Life Water Quality Guidance Values	Human Health Water Quality Criteria	Freshwater, Chronic (µg/L)	Freshwater, Chronic (µg/L)	Water + Organism (µg/L)	Acenaphthene	n/a	520	95	Anthracene	n/a	2,900	n/a	Benzo(a)anthracene	n/a	n/a	0.0013	Benzo(a)pyrene	n/a	n/a	0.0013	Benzo(e)pyrene	n/a	n/a	n/a	Benzo(b)fluoranthene	n/a	n/a	0.0013	Benzo(j)fluoranthene	n/a	n/a	n/a	Benzo(k)fluoranthene	n/a	n/a	0.0013	Benzo(g,h,i)perylene	n/a	n/a	n/a
		Toxic Pollutant		Aquatic Life Water Quality Criteria	Aquatic Life Water Quality Guidance Values	Human Health Water Quality Criteria																																							
			Freshwater, Chronic (µg/L)	Freshwater, Chronic (µg/L)	Water + Organism (µg/L)																																								
		Acenaphthene	n/a	520	95																																								
		Anthracene	n/a	2,900	n/a																																								
		Benzo(a)anthracene	n/a	n/a	0.0013																																								
		Benzo(a)pyrene	n/a	n/a	0.0013																																								
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Benzo(k)fluoranthene	n/a	n/a	0.0013																																										
Benzo(g,h,i)perylene	n/a	n/a	n/a																																										

# Toxic Pollutant Profile | Polycyclic Aromatic Hydrocarbons (PAHs)

Chrysene	n/a	n/a	130
Dibenzo(a,h)anthracene	n/a	n/a	0.0013
Fluoranthene	n/a	n/a	14
Fluorene	n/a	n/a	390
Indeno(1,2,3-cd)pyrene	n/a	n/a	0.0013
Naphthalene	n/a	620	n/a
Phenanthrene	n/a	n/a	n/a
Pyrene	n/a	n/a	290

Source: (DEQ, 2017)

Priority Pollutant (EPA's Clean Water Act): Yes

TRI-Listed Pollutant (EPA's EPCRA Section 313): Yes

Reportable Pollutant (EPA's CERCLA's Section 304): Yes

Source: (EPA, 2014, 2015, 2016)

## Abbreviations / Acronyms

atm-m<sup>3</sup>/mol – atmosphere-cubic meters per mole

CASRN – Chemical Abstract Registry Number

CERCLA – Comprehensive Environmental Response, Compensation and Liability Act

°C – degrees Celsius

EPA – Environmental Protection Agency

EPCRA – Environmental Planning and Community Right-to-Know Act

g/cm<sup>3</sup> – grams per centimeter cubed

IUPAC – International Union of Pure and Applied Chemistry

L/kg – liters per kilogram

log – log base 10 of K (i.e., 10<sup>K</sup>)

mmHg – millimeters mercury

mol/L – moles per liter

n/a – not available / not analyzed

µg/liter – micrograms per liter

## References

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# Toxic Pollutant Profile | Polychlorinated biphenyls (PCBs)

## Profile

Classification: Polychlorinated biphenyls (PCBs)

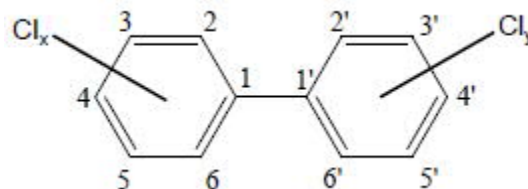
CASRN: 1336-36-3 (varies for individual congeners)

Molecular Formula:  $C_{12}H_{1-9}Cl_{1-10}$

IUPAC Name: varies

Synonyms: n/a

Source: (ATSDR, 2000; EPA, 2015)



## Description

Polychlorinated biphenyls (PCBs) are a group of man-made organic chemicals that consist of carbon, hydrogen, and chlorine atoms (i.e., chlorinated hydrocarbons) ranging in consistency from oils to solids. PCBs were manufactured from 1929 until it was banned in 1979. PCBs are comprised of one to 10 chlorine atoms attached to a biphenyl molecule (an aromatic hydrocarbon) composed of two six-carbon atom phenyl rings, for a total of 12 carbons (with six double carbon-carbon bonds). Up to 209 different chlorinated PCB compounds, known as congeners, are possible. The large number of congeners is related to the number of chlorines attached to, and their position on, each biphenyl ring (ATSDR, 2000; Erickson D., 1997).

## Chemical Characteristics

Molecular Weight (g/mol)	189 to 499
Density (g/cm <sup>3</sup> )	1.13 to 1.94 @ 25°C
Water Solubility (mg/L)	$7.43 \times 10^{-6}$ to 4.83 @ 25°C
Boiling Point (°C)	274 to 320
Melting Point (°C)	16 to 306
Octanol-water partitioning coefficient (log $K_{ow}$ )	4.53 to 9.56
Octanol-air partitioning coefficient (log $K_{oa}$ )	$2.9 \times 10^{-5}$ to 11.7
Organic carbon-water partitioning coefficient (log $K_{oc}$ )	3.47 to 6.16
Vapor Pressure (mmHg)	$7.60 \times 10^{-9}$ to 0.0105 @ 25°C
Henry's Law Constant (atm-m <sup>3</sup> /mol)	$1.30 \times 10^{-6}$ to $9.40 \times 10^{-3}$ @ 25°C

Source: (EPA, 2017; SRC, 2013)

Note: chemical characteristics for each PCB congener are provided in the Toxic Pollutant Chemical Characteristics table (Table A9).

## Organic Solvents

PCB congeners (and Aroclors) are not very soluble in water or organic solvents. Some congeners (and Aroclors) can be very soluble in organic solvents.

Source: (ATSDR, 2000; EPA, 2017)

# Toxic Pollutant Profile | Polychlorinated biphenyls (PCBs)

Sources	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>• None</li> </ul> <p>Non-natural Sources &amp; Uses:</p> <ul style="list-style-type: none"> <li>• Manufacturing/processing (historically from 1929 to 1979)</li> <li>• Closed applications (transformers, capacitors, heat transfer and hydraulic fluids)</li> <li>• Open applications (flame retardants, inks, paint/plasticizers, carbonless copy paper, pesticide extenders, wire insulators, cutting oils, etc)</li> </ul> <p>Releases to Air</p> <p>Emissions of P to the atmosphere are reported from legacy use and manufacturing, volatilization from PCB-containing soil and water, uncontrolled landfills, hazardous waste sites, incineration of PCB-containing materials, and volatilization from leaking electrical equipment.</p> <p>Releases to Soil</p> <p>Releases of PCBs to soil are reported from legacy use and manufacturing, discharges of PCB-containing wastewater and stormwater from various sources handling/manufacturing PCBs, releases of PCB-containing fluids including transformers and capacitors, PCB-containing sludge applications to land, releases from landfills and hazardous waste sites, and atmospheric deposition.</p> <p>Releases to Water</p> <p>Releases of PCBs to surface waters and groundwater are reported from legacy use and manufacturing, discharges of PCB-containing wastewater and stormwater from various sources handling/manufacturing PCBs, releases of PCB-containing fluids including transformers and capacitors, runoff of PCB-containing sludge applications to land, leaching from landfills and hazardous waste sites, and atmospheric deposition.</p> <p><u>Source:</u> (ATSDR, 2000)</p>
Transport and Fate	<p>Transformation &amp; Degradation</p> <p>PCBs can volatilize, photolyze, oxidize, and biodegrade. The rate/extent of transformation/degradation is dependent on the molecular structures (i.e., the position of the chlorine atom), environmental factors, and presence of other contaminants. Some PCB congeners are more susceptible to certain degradation processes than others.</p> <ul style="list-style-type: none"> <li>• In the atmosphere, vapor-phase reactions with hydroxyl radicals are the dominant process. Lifetime values in the atmosphere depend on the degree of chlorination, with longer times exhibited by PCBs with higher chlorine content. Photolysis and chemical reactions of congeners is not yet well studies.</li> <li>• In water, hydrolysis and oxidation are not considered important processes for degradation; photolysis appears to be the significant process. Rates of degradation for photolysis increases as the degree of chlorination increases. Biodegradation in water is an aerobic process; lower chlorinated PCBs dissolve more than higher chlorinated PCBs and are thus able to biodegrade more under aerobic conditions. Biodegradation rates may be slower in marine water compared to fresh water.</li> <li>• In soil/sediment, biodegradation is a major process for PCB degradation (under aerobic and anaerobic conditions) due to PCBs' preference to partition to soil/sediment and the presence of microorganisms. Photolysis of PCBs from the soil surface may occur and may also undergo base-catalyzed dechlorination, but likely to be insignificant. PCBs with less than four chlorine atoms are considered non-persistent and are readily degraded. PCBs</li> </ul>

with five or more chlorine atoms are considered persistent and are not readily degraded. PCBs strongly sorbed to soil/sediment are not available for degradation.

## Partitioning

Partitioning of PCBs is dependent on each individual congener's physical and chemical properties. PCBs generally have low water solubility and high affinity for soil/sediment. Higher chlorinated PCBs tend to sorb (less mobile) while lower chlorinated PCBs tend to volatilize (more mobile). Atmospheric transport is the predominant mechanism for PCBs. The rate of atmospheric deposition depends on individual PCB properties. PCBs can cycle between air, soil, and water.

- In air, PCBs are found in the vapor phase and sorbed to particulates. PCBs in the vapor phase (lower chlorination) are more mobile and transported further than particle-sorbed PCBs. PCBs are removed from the atmosphere via wet and dry deposition.
- In water, PCBs exist as dissolved, particulate, and colloid associated. Heavier chlorinated PCBs are found as particulates or colloids in the water column (less water soluble) while lighter chlorinated PCBs are found dissolved (more water soluble). PCBs are transported by diffusion and currents and removed from the water column, sorbing to suspended particles (soil/sediment), volatilizing from the water surface, or bioaccumulating in plants/aquatic species.
- In soil, PCBs are unlikely to migrate to groundwater due to their strong sorption capabilities to soil. PCBs with lower chlorination can leach but not extensively. However, leaching occurs significantly in the presence of organic solvents. PCBs can volatilize from the soil surface.

## General partitioning phase based on PCB chemical structure:

- 0 to 1 chlorine atoms – remains in atmosphere
- 1 to 4 chlorine atoms – gradually migrates toward polar latitudes in series of volatilization/deposition cycles
- 4 to 8 chlorine atoms – remains in mid-latitudes
- 8 to 9 chlorine atoms – remains close to source of contamination

## Bioaccumulation/Bioconcentration

Bioaccumulation/bioconcentration of PCBs in the environment is dependent on the congener. PCBs can bioaccumulate in plants, aquatic organisms, and animals. Bioaccumulation of PCBs increases with higher chlorination and lower water solubility. Lower chlorinated PCBs are readily taken up by organisms but readily eliminated/metabolized. Higher chlorinated PCBs are not significantly bioaccumulated (not readily available). PCBs with five to seven chlorine atoms are bioavailable and resistant to degradation in organisms.

Bioconcentration Factor	Bioaccumulation Factor
Fresh water – low chlorination: $5 \times 10^2$ to $4 \times 10^4$	2,050 to over 3.9 million
Fresh water – high chlorination: $1 \times 10^3$ to $3 \times 10^5$	

## Notes:

BCF and BAF are congener specific, and thus, vary widely.  
BCF and BAF values reported for fish

Source: (ATSDR, 2000)

# Toxic Pollutant Profile | Polychlorinated biphenyls (PCBs)

Water Quality Regulations	Oregon Water Quality Standards		
	Aquatic Life Water Quality Criteria	Aquatic Life Water Quality Guidance Values	Human Health Water Quality Criteria
	Freshwater, Chronic (µg/L)	Freshwater, Chronic (µg/L)	Water + Organism (µg/L)
	0.014	n/a	0.0000064
	<p>Source: (DEQ, 2017)</p> <p>Priority Pollutant (EPA’s Clean Water Act): Yes TRI-Listed Pollutant (EPA’s EPCRA Section 313): Yes Reportable Pollutant (EPA’s CERCLA’s Section 304): Yes</p> <p>Source: (EPA, 2014, 2015, 2016)</p>		
Abbreviations / Acronyms	<p>atm-m<sup>3</sup>/mol – atmosphere-cubic meters per mole</p> <p>CASRN – Chemical Abstract Registry Number</p> <p>CERCLA – Comprehensive Environmental Response, Compensation and Liability Act</p> <p>°C – degrees Celsius</p> <p>EPA – Environmental Protection Agency</p> <p>EPCRA – Environmental Planning and Community Right-to-Know Act</p> <p>g/cm<sup>3</sup> – grams per centimeter cubed</p> <p>IUPAC – International Union of Pure and Applied Chemistry</p> <p>L/kg – liters per kilogram</p> <p>log – log base 10 of K (i.e., 10<sup>K</sup>)</p> <p>mmHg – millimeters mercury</p> <p>mol/L – moles per liter</p> <p>n/a – not available / not analyzed</p> <p>µg/liter – micrograms per liter</p>		
References	<p>ATSDR. (2000). Toxicological Profile for PCBs. Retrieved from <a href="https://www.atsdr.cdc.gov/toxprofiles/index.asp#D">https://www.atsdr.cdc.gov/toxprofiles/index.asp#D</a></p> <p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p> <p>EPA. (2014). Priority Pollutant List. Retrieved from <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a></p> <p>EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <a href="https://www.epa.gov/epcra/epcracerclaa-ss112r-consolidated-list-lists-march-2015-version">https://www.epa.gov/epcra/epcracerclaa-ss112r-consolidated-list-lists-march-2015-version</a></p>		

	<p>EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from <a href="https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf">https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf</a></p> <p>EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <a href="https://comptox.epa.gov/dashboard">https://comptox.epa.gov/dashboard</a></p> <p>Erickson D., M. (1997). Analytical Chemistry of PCBs (Second).</p> <p>SRC. (2013). FatePointers Search Module, PhysProp. Retrieved December 1, 2017, from <a href="http://esc.srcinc.com/fatepointer/search.asp">http://esc.srcinc.com/fatepointer/search.asp</a></p>
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<p>Profile</p>	<div> <div>Classification: Metal</div> <div>CASRN: 7440-22-4</div> <div>Molecular Formula: Ag</div> <div>IUPAC Name: Silver</div> <div>Synonyms: Argentum</div> <div>Source: (EPA, 2017)</div> </div> <div> <div>Description</div> <div>Silver occurs naturally in the environment as a silver metal combined with other elements such as sulfide, chloride, and nitrate. Silver is found as a powdery white (silver nitrate and silver chloride) or dark-gray to black compound (i.e., silver sulfide and silver oxide).</div> </div> <div> <div>Chemical Characteristics</div> <table border="1"> <tr> <td>Molecular Weight (g/mol)</td><td>108</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>10.5 @ 20°C</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>70,480 @ 25°C</td></tr> <tr> <td>Boiling Point (°C)</td><td>2,212</td></tr> <tr> <td>Melting Point (°C)</td><td>962</td></tr> <tr> <td>Octanol-water partitioning coefficient (log K<sub>ow</sub>)</td><td>0.230</td></tr> <tr> <td>Octanol-air partitioning coefficient (log K<sub>oa</sub>)</td><td>0.229</td></tr> <tr> <td>Organic carbon-water partitioning coefficient (log K<sub>oc</sub>)</td><td>0.199</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td>4.24x10<sup>-9</sup> @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td>0.0245 @ 25°C</td></tr> </table> <div>Sources: (ATSDR, 1990; EPA, 2018; SRC, 2013)</div> </div> <div> <div>Organic Solvents</div> <div>In water and nitric acid, silver has a low solubility. In sulfuric acid and alkali cyanide solutions, silver has a high solubility.</div> <div>Sources: (ATSDR, 1990; NLM, 2017)</div> </div>	Molecular Weight (g/mol)	108	Density (g/cm <sup>3</sup> )	10.5 @ 20°C	Water Solubility (mg/L)	70,480 @ 25°C	Boiling Point (°C)	2,212	Melting Point (°C)	962	Octanol-water partitioning coefficient (log K <sub>ow</sub> )	0.230	Octanol-air partitioning coefficient (log K <sub>oa</sub> )	0.229	Organic carbon-water partitioning coefficient (log K <sub>oc</sub> )	0.199	Vapor Pressure (mmHg)	4.24x10 <sup>-9</sup> @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	0.0245 @ 25°C
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<p>Sources</p>	<div>Natural Sources</div> <ul style="list-style-type: none"> <li>Natural weathering of silver-bearing rocks and soil</li> </ul> <div>Non-natural Sources &amp; Uses:</div> <ul style="list-style-type: none"> <li>Mines producing silver</li> <li>Surgical prostheses and/or splints</li> <li>Coinage (discontinued in 1970)</li> <li>Photographic materials</li> <li>Recycled scrap materials containing silver (electrical, industrial-alloy, and art industries)</li> <li>Electric/electronic products</li> <li>Brazing alloys and solders</li> <li>Electroplated ware, sterling ware, and jewelry</li> <li>Mirrors</li> <li>Dental amalgam</li> </ul>																				

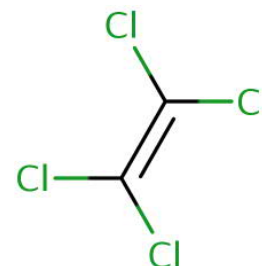
	<ul style="list-style-type: none"> <li>• Medical supplies (treatment of burns)</li> <li>• Catalyst in the manufacture of formaldehyde and ethylene oxide</li> <li>• Chemical analyses involving titration</li> <li>• Cloud seeding</li> <li>• Antibacterial agent (silver ion)</li> <li>• Wastewater/sewage treatment plant discharges</li> <li>• Burning of fossil fuels</li> <li>• Cement manufacturing</li> <li>• Pesticide for use in disinfectants, sanitizers, and fungicides (first registered in 1954) (active agent for purification/disinfection of drinking water/swimming pools)</li> </ul> <p>Releases to Air Emissions of silver are reported from production processes and consumptive use, including petroleum/coal combustion, steel/iron production, and urban refuse. Silver is released to the atmosphere as an aerosol.</p> <p>Releases to Soil Releases of silver to soil are reported from production processes and consumptive use, primarily from the photographic industry (manufacturing and developing), leachate from metal tailings (mine sites) and sewage sludge (photographic materials) as agricultural amendments.</p> <p>Releases to Water Releases of silver to surface waters and groundwater are reported from production processes and consumptive use, including photographic manufacturing and developing. Releases of silver are also reported from leachates containing silver leaching into groundwater, in addition to wastewater effluent (receiving silver-contaminants from industrial processes such as municipal incinerators and quench water/fly ash scrubber water).</p> <p>Source: (ATSDR, 1990)</p>
Transport and Fate	<p>Transformation &amp; Degradation Silver is an element and therefore, does not breakdown. However, silver can change its form by combining with other substances, releasing toxic gases and vapors. . Biotransformation of silver is not a significant process (such as oxides of nitrogen).</p> <ul style="list-style-type: none"> <li>• In air, metallic silver particulates emitted from the burning of fossil fuels and municipal refuse become coated with silver oxide, silver sulfide, and silver carbonate as the particles cool and undergo deposition. Silver particles can be transported long distances and undergo dry/wet atmospheric deposition.</li> <li>• In water, silver may form complex ions in fresh water with chlorides, ammonium, and sulfates.</li> <li>• In soil, silver forms complexes with inorganic chemicals and humic substances in soils.</li> </ul> <p>Partitioning The transport and partitioning of silver is dependent on the particular form of the compound.</p> <ul style="list-style-type: none"> <li>• In water, the major forms of silver are the monovalent ion (form of sulfate, bicarbonate, or sulfate salts), part of more complex ions with chlorides and sulfates, and integral part of, or adsorbed onto, particulate matter. Silver may become adsorbed or incorporated into aquatic biota.</li> </ul>

	<ul style="list-style-type: none"><li>Silver may become adsorbed onto humic complexes and suspended particulates. Silver strongly precipitates as sulfide in areas with decaying animal and plant material, and well drained soils. Sorption is the dominant process leading to partitioning of silver in sediments.</li></ul> <p>Bioaccumulation/Bioconcentration</p> <p>Silver bioconcentrates to a limited extent in algae, mussels, clams, and other aquatic organisms.. Silver bioaccumulate in bluegill and largemouth bass. Limited data is available for BCF/BAF values</p> <p>Source: (ATSDR, 1990)</p>						
Water Quality Regulations	<p>Oregon Water Quality Standards</p> <table><tr><th>Aquatic Life Water Quality Criteria Freshwater, Chronic (µg/L)</th><th>Aquatic Life Water Quality Guidance Values Freshwater, Chronic (µg/L)</th><th>Human Health Water Quality Criteria Water + Organism (µg/L)</th></tr><tr><td>0.1</td><td>n/a</td><td>n/a</td></tr></table> <p>Source: (DEQ, 2017)</p> <p>Priority Pollutant (EPA’s Clean Water Act): Yes TRI-Listed Pollutant (EPA’s EPCRA Section 313): Yes Reportable Pollutant (EPA’s CERCLA’s Section 304): Yes</p> <p>Sourced: (EPA, 2014, 2015, 2016)</p>	Aquatic Life Water Quality Criteria Freshwater, Chronic (µg/L)	Aquatic Life Water Quality Guidance Values Freshwater, Chronic (µg/L)	Human Health Water Quality Criteria Water + Organism (µg/L)	0.1	n/a	n/a
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References	<p>ATSDR. (1990). Toxicological Profile for Silver. <a href="https://doi.org/10.1017/CBO9781107415324.004">https://doi.org/10.1017/CBO9781107415324.004</a></p> <p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p>						

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- EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <https://www.epa.gov/epcra/epcracerclaa-ss112r-consolidated-list-lists-march-2015-version>
- EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from [https://ofmpub.epa.gov/apex/guideme\\_ext/guideme\\_ext/r/files/static/v3321/rfi/RY\\_2016\\_RFI.pdf](https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf)
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- NLM. (2017). PubChem Substance and Compound Databases. Retrieved November 1, 2017, from <https://pubchem.ncbi.nlm.nih.gov/>
- SRC. (2013). FatePointers Search Module, PhysProp. Retrieved December 1, 2017, from <http://esc.srcinc.com/fatepointer/search.asp>

# Toxic Pollutant Profile | Tetrachloroethene (PCE)

<p>Profile</p>	<p>Classification: Volatile Organic Compound (VOC)</p> <p>CASRN: 127-18-4</p> <p>Molecular Formula: C<sub>2</sub>Cl<sub>4</sub></p> <p>IUPAC Name: 1,1,2,2-tetrachloroethene</p> <p>Synonyms: Tetrachloroethylene, Perchloroethylene, PERC</p> <p>Source: (EPA, 2017; NLM, 2017)</p> <p>Description</p> <p>PCE is a colorless, volatile, nonflammable, dense non-aqueous phase liquid (DNAPL) liquid, and is a man-made chlorinated hydrocarbon. PCE is primary used as a solvent (a halogenated organic solvent) for organic materials.</p> <p>Chemical Characteristics</p> <table border="1"> <tr> <td>Molecular Weight (g/mol)</td><td>166</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>1.65 @ 20°C</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>206 @ 25°C</td></tr> <tr> <td>Boiling Point (°C)</td><td>121</td></tr> <tr> <td>Melting Point (°C)</td><td>-22</td></tr> <tr> <td>Octanol-water partitioning coefficient (log K<sub>ow</sub>)</td><td>3.40</td></tr> <tr> <td>Octanol-air partitioning coefficient (log K<sub>oa</sub>)</td><td>3.48</td></tr> <tr> <td>Organic carbon partitioning coefficient (log K<sub>oc</sub>)</td><td>2.37</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td>18.5 @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td>0.0180 @ 25°C</td></tr> </table> <p>Source: (ATSDR, 2014; EPA, 2018)</p> <p>Organic Solvents</p> <p>Miscible with alcohol, ether, chloroform, benzene, solvent, hexane, and most fixed volatile oils. In water and nitric acid, silver has a low solubility. In sulfuric acid and alkali cyanide solutions, silver has a high solubility.</p> <p>Source: (ATSDR, 2014)</p>	Molecular Weight (g/mol)	166	Density (g/cm <sup>3</sup> )	1.65 @ 20°C	Water Solubility (mg/L)	206 @ 25°C	Boiling Point (°C)	121	Melting Point (°C)	-22	Octanol-water partitioning coefficient (log K <sub>ow</sub> )	3.40	Octanol-air partitioning coefficient (log K <sub>oa</sub> )	3.48	Organic carbon partitioning coefficient (log K <sub>oc</sub> )	2.37	Vapor Pressure (mmHg)	18.5 @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	0.0180 @ 25°C
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Henry's Law Constant (atm-m <sup>3</sup> /mol)	0.0180 @ 25°C																				
<p>Sources</p>	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>None</li> <li>Temperate and subtropical marine macroalgae reported to produce PCE</li> </ul> <p>Non-natural Sources &amp; Uses:</p> <ul style="list-style-type: none"> <li>Dry cleaning/textile processing solvent</li> <li>Chemical solvent (for cleaning/degreasing)</li> <li>Vapor/liquid degreasing agent (for metal and fabricated materials)</li> <li>Soot removal from boilers</li> <li>Dissolve fats, greases, waxes, and oils</li> </ul> <p>Releases to Air</p> <p>Emissions of PCE to the atmosphere are reported from manufacturing/processing and dry cleaning facilities, in addition to chlorohydrocarbon production facilities forming byproducts of PCE.</p>																				



	<p><b>Releases to Soil</b> Releases of PCE to soil are reported from off-site disposal, including from underground injection leaching/releases, and landfill leaching from sludges and filters. Releases of PCE to soil also reported from leaking underground storage tanks (LUSTs).</p> <p><b>Releases to Water</b> Releases of PCE to surface waters and groundwater are reported from inappropriate releases from dry cleaning facilities and landfills and wastewater treatment facility discharges (receiving aqueous wastes from industrial facilities). Releases of PCE to surface waters also occur from the leaching of contaminated pipes.</p> <p><u>Source:</u> (ATSDR, 2014)</p>				
Transport and Fate	<p><b>Transformation &amp; Degradation</b> PCE is dehalogenated to trichloroethene (TCE), then to cis/trans-dichloroethylene (DCE), then to vinyl chloride, and eventually to ethane.</p> <ul style="list-style-type: none"> <li>• In the atmosphere, PCE transforms via reactions with photochemically-produced hydroxyl radicals. PCE can under go long range atmospheric transport and dry/wet atmospheric deposition.</li> <li>• In water, hydrolysis does not occur under normal environmental conditions.</li> <li>• In soil/sediment, PCE biodegrades via reductive dehalogenation by anaerobes.</li> </ul> <p><b>Partitioning</b> PCE is primarily found in the atmosphere; it has low solubility in water and medium to high mobility in soil.</p> <ul style="list-style-type: none"> <li>• In air, PCE partitions primarily to the atmosphere. PCE in the vapor phase can migrate from contaminated water or soil to above ground (including inside buildings) via vapor intrusion.</li> <li>• In water, PCE volatilizes rapidly from surface water. Aqueous solubility of PCE is enhanced by the presence of humic substances in surface water and wastewater.</li> <li>• In soil, PCE can volatilize or leach into soil. Sorption of PCE is a function of the organic carbon content in sediments and soils. Volatilization and movement in the gas phase accounts for a large portion of PCE transport in soil (resulting in vapor intrusion into buildings).</li> </ul> <p><b>Bioaccumulation/Bioconcentration</b> PCE can bioaccumulate in marine organisms (including fish and seals). PCE has a low tendency for bioconcentration in aquatic organisms, animals, and plants. Biomagnification in the food chain does not appear to be significant.</p> <table border="1"> <tr> <th>Bioconcentration Factor</th><th>Bioaccumulation Factor</th></tr> <tr> <td>10 to 100</td><td>n/a</td></tr> </table> <p><u>Note:</u> BCF reported for fish</p> <p><u>Source:</u> (ATSDR, 2014)</p>	Bioconcentration Factor	Bioaccumulation Factor	10 to 100	n/a
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10 to 100	n/a				

# Toxic Pollutant Profile | Tetrachloroethene (PCE)

Water Quality Regulations	Oregon Water Quality Standards		
	Aquatic Life Water Quality Criteria	Aquatic Life Water Quality Guidance Values	Human Health Water Quality Criteria
	Freshwater, Chronic (µg/L)	Freshwater, Chronic (µg/L)	Water + Organism (µg/L)
	n/a	840	0.24
	<u>Source:</u> (DEQ, 2017)		
	Priority Pollutant (EPA's Clean Water Act): Yes		
	TRI-Listed Pollutant (EPA's EPCRA Section 313): Yes		
	Reportable Pollutant (EPA's CERCLA's Section 304): Yes		
	<u>Source:</u> (EPA, 2014, 2015, 2016)		
Abbreviations / Acronyms	atm-m <sup>3</sup> /mol – atmosphere-cubic meters per mole		
	CASRN – Chemical Abstract Registry Number		
	CERCLA – Comprehensive Environmental Response, Compensation and Liability Act		
	°C – degrees Celsius		
	EPA – Environmental Protection Agency		
	EPCRA – Environmental Planning and Community Right-to-Know Act		
	g/cm <sup>3</sup> – grams per centimeter cubed		
	IUPAC – International Union of Pure and Applied Chemistry		
	L/kg – liters per kilogram		
	log – log base 10 of K (i.e., 10 <sup>K</sup> )		
	mmHg – millimeters mercury		
	mol/L – moles per liter		
	n/a – not available / not analyzed		
	µg/liter – micrograms per liter		
References	ATSDR. (2014). Toxicological Profile for Tetrachloroethylene. <a href="https://doi.org/http://www.atsdr.cdc.gov/toxprofiles/tp18.pdf">https://doi.org/http://www.atsdr.cdc.gov/toxprofiles/tp18.pdf</a>		
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	<p>EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from <a href="https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf">https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf</a></p> <p>EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <a href="https://comptox.epa.gov/dashboard">https://comptox.epa.gov/dashboard</a></p> <p>EPA. (2018). Estimation Programs Interface Suite. Retrieved from <a href="https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface#cite">https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface#cite</a></p> <p>NLM. (2017). PubChem Substance and Compound Databases. Retrieved November 1, 2017, from <a href="https://pubchem.ncbi.nlm.nih.gov/">https://pubchem.ncbi.nlm.nih.gov/</a></p>
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TI

<p>Profile</p>	<p>Classification: Metal</p> <p>CASRN: 7440-28-0</p> <p>Molecular Formula: TI</p> <p>IUPAC Name: Thallium</p> <p>Synonyms: none</p> <p>Source: (EPA, 2017)</p> <p>Description</p> <p>Thallium occurs naturally in the environment found primary as the monovalent ion. Several thallium compounds are formed with bromine, chlorine, fluorine, and done to create salts. Thallium is found as a blue-white metal. Thallium is primarily mined from the earth but also recovered as a byproduct from other processes such as smelting zinc, copper, and lead ores.</p> <p>Chemical Characteristics</p> <table border="1"> <tr> <td>Molecular Weight (g/mol)</td><td>204</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>11.8 @ 25°C</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>26,480 @ 25°C</td></tr> <tr> <td>Boiling Point (°C)</td><td>1,457</td></tr> <tr> <td>Melting Point (°C)</td><td>304</td></tr> <tr> <td>Octanol-water partitioning coefficient (log K<sub>ow</sub>)</td><td>0.230</td></tr> <tr> <td>Octanol-air partitioning coefficient (log K<sub>oa</sub>)</td><td>0.229</td></tr> <tr> <td>Organic carbon-water partitioning coefficient (log K<sub>oc</sub>)</td><td>0.199</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td>4.24x10<sup>-9</sup> @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td>0.0245 @ 25°C</td></tr> </table> <p>Source: (ATSDR, 1992; EPA, 2018; SRC, 2013)</p> <p>Organic Solvents</p> <p>Soluble in nitric or sulfuric acid. Insoluble in water.</p> <p>Source: (ATSDR, 1992; NLM, 2017)</p>	Molecular Weight (g/mol)	204	Density (g/cm <sup>3</sup> )	11.8 @ 25°C	Water Solubility (mg/L)	26,480 @ 25°C	Boiling Point (°C)	1,457	Melting Point (°C)	304	Octanol-water partitioning coefficient (log K <sub>ow</sub> )	0.230	Octanol-air partitioning coefficient (log K <sub>oa</sub> )	0.229	Organic carbon-water partitioning coefficient (log K <sub>oc</sub> )	0.199	Vapor Pressure (mmHg)	4.24x10 <sup>-9</sup> @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	0.0245 @ 25°C
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<p>Sources</p>	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>Natural weathering of thallium-bearing rocks and soil</li> </ul> <p>Non-natural Sources &amp; Uses:</p> <ul style="list-style-type: none"> <li>Mines producing thallium</li> <li>Semiconductors (thallium sulfate)</li> <li>Thermometers</li> <li>Optical systems</li> <li>Photoelectric cells</li> <li>Chemical intermediate for other thallium compounds and metals</li> <li>Solution preparation for separating ore constituents (thallium acetate)</li> <li>Chlorination catalyst (thallium chloride)</li> <li>Signals at sea (thallium nitrate)</li> <li>Low melting glass production</li> </ul>																				

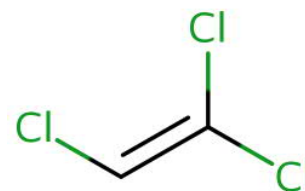
	<ul style="list-style-type: none"> <li>• Fireworks</li> <li>• Oxidizing agents</li> <li>• Artificial gems (thallium oxide)</li> <li>• Pesticides (historical, banned in 1972)</li> </ul> <p>Releases to Air Emissions of thallium are reported from production processes and consumptive use, including coal burning power plants, cement factories, and ferrous/nonferrous smelting, alloy manufacturing, artificial gem manufacturing, electronic equipment manufacturing, optical glass manufacturing, and domestic heating plants.</p> <p>Releases to Soil Releases of thallium to soil are reported from production processes and consumptive use, including solid waste from coal combustion and smelting, agricultural pesticides (historical), releases from hazardous waste sites, and leaching from landfills. Natural sources include atmospheric deposition.</p> <p>Releases to Water Releases of thallium to surface waters are reported from production processes and consumptive use, including wastewater effluent from nonferrous metals, iron and steel manufacturing, mining and ore processing, inorganic chemicals refining, agricultural pesticides (historical) runoff, and releases from hazardous waste sites and landfills. Natural sources include atmospheric deposition.</p> <p><u>Source:</u> (ATSDR, 1992)</p>
Transport and Fate	<p>Transformation &amp; Degradation Thallium transformations and degradation is not well understood.</p> <ul style="list-style-type: none"> <li>• In air, thallium oxidizes slowly. Photochemical reactions are not known to be a significant process for thallium transformations.</li> <li>• In water, thallium transformation and types of processes is not known.</li> <li>• In soil, thallium is not biotransformed.</li> </ul> <p>Partitioning The transport and partitioning of thallium is dependent on the speciation complex and the environmental media.</p> <ul style="list-style-type: none"> <li>• In air, thallium exists as an oxide, hydroxide, sulfate, or sulfide compound. Thallium sulfate and hydroxide partition to water vapor because of their solubility in water and may be deposited via atmospheric deposition. Thallium oxides are less soluble and may only undergo atmospheric dispersion and settle via gravity.</li> <li>• In water, thallium exists primarily in the monovalent ion form but may also be in the trivalent (thallium (III)) form in oxidizing conditions. Thallium forms complexes with halogens, oxygen, and sulfur and precipitates as solid mineral phases. Thallium may partition to soil/sediments.</li> <li>• In soil, thallium may be sorbed but specific information is not known.</li> </ul> <p>Bioaccumulation/Bioconcentration Bioconcentration of thallium occurs in aquatic and terrestrial organisms. Bioaccumulation of thallium in terrestrial and aquatic organisms is not known to occur.</p>

	<table><tr><td>Bioconcentration Factor</td><td>Bioaccumulation Factor</td></tr><tr><td>27 to 1,430</td><td>n/a</td></tr></table> <p><u>Note:</u> BCF reported for fish</p> <p><u>Source:</u> (ATSDR, 1992)</p>	Bioconcentration Factor	Bioaccumulation Factor	27 to 1,430	n/a		
Bioconcentration Factor	Bioaccumulation Factor						
27 to 1,430	n/a						
Water Quality Regulations	<p>Oregon Water Quality Standards</p> <table><tr><td>Aquatic Life Water Quality Criteria Freshwater, Chronic (µg/L)</td><td>Aquatic Life Water Quality Guidance Values Freshwater, Chronic (µg/L)</td><td>Human Health Water Quality Criteria Water + Organism (µg/L)</td></tr><tr><td>n/a</td><td>40</td><td>0.043</td></tr></table> <p><u>Source:</u> (DEQ, 2017)</p> <p>Priority Pollutant (EPA’s Clean Water Act): Yes TRI-Listed Pollutant (EPA’s EPCRA Section 313): Yes Reportable Pollutant (EPA’s CERCLA’s Section 304): Yes</p> <p><u>Source:</u> (EPA, 2014, 2015, 2016)</p>	Aquatic Life Water Quality Criteria Freshwater, Chronic (µg/L)	Aquatic Life Water Quality Guidance Values Freshwater, Chronic (µg/L)	Human Health Water Quality Criteria Water + Organism (µg/L)	n/a	40	0.043
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Abbreviations / Acronyms	<p>atm-m<sup>3</sup>/mol – atmosphere-cubic meters per mole</p> <p>CASRN – Chemical Abstract Registry Number</p> <p>CERCLA – Comprehensive Environmental Response, Compensation and Liability Act</p> <p>°C – degrees Celsius</p> <p>EPA – Environmental Protection Agency</p> <p>EPCRA – Environmental Planning and Community Right-to-Know Act</p> <p>g/cm<sup>3</sup> – grams per centimeter cubed</p> <p>IUPAC – International Union of Pure and Applied Chemistry</p> <p>L/kg – liters per kilogram</p> <p>log – log base 10 of K (i.e., 10<sup>K</sup>)</p> <p>mm Hg – millimeters mercury</p> <p>mol/L – moles per liter</p> <p>n/a – not available / not analyzed</p> <p>µg/liter – micrograms per liter</p>						
References	<p>ATSDR. (1992). Toxicological Profile for Thallium. Retrieved from <a href="https://www.atsdr.cdc.gov/toxprofiles/index.asp#D">https://www.atsdr.cdc.gov/toxprofiles/index.asp#D</a></p> <p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p> <p>EPA. (2014). Priority Pollutant List. Retrieved from <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a></p>						

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- EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from [https://ofmpub.epa.gov/apex/guideme\\_ext/guideme\\_ext/r/files/static/v3321/rfi/RY\\_2016\\_RFI.pdf](https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf)
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# Toxic Pollutant Profile | Trichloroethene (TCE)

<p>Profile</p>	<p>Classification: Volatile Organic Compound (VOC)</p> <p>CASRN: 79-01-6</p> <p>Molecular Formula: <math>C_2HCl_3</math></p> <p>IUPAC Name: 1,1,2-trichloroethene</p> <p>Synonyms: Trichloroethylene, Ethinyl Trichloride, Trilene</p> <p>Source: (EPA, 2017; NLM, 2017)</p> <p>Description</p> <p>TCE is a colorless, volatile, nonflammable, dense non-aqueous phase liquid (DNAPL) liquid, man-made chlorinated hydrocarbon. TCE is primary used as a solvent for organic materials. TCE is a halogenated organic solvent.</p> <p>Chemical Characteristics</p> <table border="1"> <tbody> <tr> <td>Molecular Weight (g/mol)</td><td>131</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>1.44 @ 25°C</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>1,280 @ 25°C</td></tr> <tr> <td>Boiling Point (°C)</td><td>87</td></tr> <tr> <td>Melting Point (°C)</td><td>-85</td></tr> <tr> <td>Octanol-water partitioning coefficient (log <math>K_{ow}</math>)</td><td>2.61</td></tr> <tr> <td>Octanol-air partitioning coefficient (log <math>K_{oa}</math>)</td><td>3.69</td></tr> <tr> <td>Organic carbon-partitioning coefficient (log <math>K_{oc}</math>)</td><td>2.10</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td>69 @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td>0.00985 @ 25°C</td></tr> </tbody> </table> <p>Sources: (ATSDR, 2014; EPA, 2018; SRC, 2013)</p> <p>Organic Solvents</p> <p>Soluble in ethanol, diethyl ether, acetone, and chloroform.</p> <p>Source: (ATSDR, 2014)</p>	Molecular Weight (g/mol)	131	Density (g/cm <sup>3</sup> )	1.44 @ 25°C	Water Solubility (mg/L)	1,280 @ 25°C	Boiling Point (°C)	87	Melting Point (°C)	-85	Octanol-water partitioning coefficient (log $K_{ow}$ )	2.61	Octanol-air partitioning coefficient (log $K_{oa}$ )	3.69	Organic carbon-partitioning coefficient (log $K_{oc}$ )	2.10	Vapor Pressure (mmHg)	69 @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	0.00985 @ 25°C
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<p>Sources</p>	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>None</li> <li>Subtropical marine macroalgae and microalgae</li> </ul> <p>Non-natural Sources &amp; Uses:</p> <ul style="list-style-type: none"> <li>Manufacturing/production (using ethylene chloride to produce TCE and tetrachlorethene [PCE])</li> <li>Manufacturing/production of polyvinyl chloride, pharmaceuticals, polychlorinated aliphatics, flame retardant chemicals, and insecticides</li> <li>Feedstock for refrigerant (hydrofluorocarbon [HFC-134a] replacing CFC-12) as a low heat transfer</li> <li>Metal degreasing (vapor degreasing of metal parts in metals/automotive industry)</li> <li>Extraction solvent for greases, oils, fats, waxes, and tars</li> <li>Scour cotton, wool, other fabrics in textile processing industry (solvent for waterless drying and finishing operations)</li> </ul>																				



	<ul style="list-style-type: none"> <li>• Addition to adhesives, lubricants, paints, varnishes, paint strippers, pesticides, and cold metal cleaners</li> <li>• General anesthetic, grain fumigant, skin wound/surgical disinfectant, pet food additive, extractant of spice oleoresins in food and production of decaffeinated coffee</li> </ul> <p><b>Releases to Air</b> Emissions of CE to the atmosphere are reported from manufacturing/processing, degreasing operations, solvent evaporation losses from adhesives, paints, coatings, and miscellaneous uses, aircraft emissions, treatment and disposal sites, water treatment facilities (via volatilization and air-stripping procedures), landfill gas emissions, municipal and hazardous waste incineration, dry cleaning, bulk gasoline terminals, agricultural livestock waste, and fuel combustion.</p> <p><b>Releases to Soil</b> Releases of TCE to soil are reported from manufacturing/production, industrial and municipal waste disposal wells (hazardous and non-hazardous), direct underground injections, surface water leaching, and landfill leachate.</p> <p><b>Releases to Water</b> Releases of TCE to surface waters and groundwater are reported from wastewater treatment facilities, manufacturing/processing (industrial wastewater discharges), and landfill leachate (leaching into groundwater).</p> <p><u>Source:</u> (ATSDR, 2014)</p>
Transport and Fate	<p><b>Transformation &amp; Degradation</b> TCE (a degradation product of PCE) degrades to cis/trans-dichloroethylene (DCE), then to vinyl chloride, and eventually to ethane.</p> <ul style="list-style-type: none"> <li>• In the atmosphere, TCE transforms via reactions with photochemically-produced hydroxyl radicals. PCE can undergo dry/wet atmospheric deposition.</li> <li>• In water, hydrolysis of PCE does not occur under normal environmental conditions.</li> <li>• In soil/sediment, TCE biodegrades via reductive dehalogenation by anaerobes.</li> </ul> <p><b>Partitioning</b> TCE partitions primarily to the atmosphere and can revolatilize after deposition; it is moderately soluble in water and highly mobile in soil.</p> <ul style="list-style-type: none"> <li>• In air, TCE partitions primarily to the atmosphere, but long-range transport is unlikely (due to its density).</li> <li>• In water, TCE volatilizes rapidly and is present in groundwater (due to its rapid leachability from soil).</li> <li>• In soil, sorption of TCE is a function of the soil moisture content (concentration decreases with increased moisture content). TCE has a medium to high mobility in soil. Volatilization and movement in the gas phase accounts for a large portion of TCE transport in soil (resulting in vapor intrusion in buildings). Volatilization of TCE from soil is slower than from water.</li> </ul> <p><b>Bioaccumulation/Bioconcentration</b> TCE has a low to moderate tendency to bioaccumulate in fish and animals. Biomagnification in the aquatic food chain is not important. TCE has a low bioconcentration potential in aquatic animals and plants.</p>

# Toxic Pollutant Profile | Trichloroethene (TCE)

	<table><tr><th>Bioconcentration Factor</th><th>Bioaccumulation Factor</th></tr><tr><td>20 to 100</td><td>n/a</td></tr></table> <p><u>Note:</u> BCF reported for fish</p> <p><u>Source:</u> (ATSDR, 2014)</p>	Bioconcentration Factor	Bioaccumulation Factor	20 to 100	n/a					
Bioconcentration Factor	Bioaccumulation Factor									
20 to 100	n/a									
Water Quality Regulations	<p>Oregon Water Quality Standards</p> <table><tr><th>Aquatic Life Water Quality Criteria</th><th>Aquatic Life Water Quality Guidance Values</th><th>Human Health Water Quality Criteria</th></tr><tr><th>Freshwater, Chronic (µg/L)</th><th>Freshwater, Chronic (µg/L)</th><th>Water + Organism (µg/L)</th></tr><tr><td>n/a</td><td>21,900</td><td>1.4</td></tr></table> <p><u>Source:</u> (DEQ, 2017)</p> <p>Priority Pollutant (EPA’s Clean Water Act): Yes TRI-Listed Pollutant (EPA’s EPCRA Section 313): Yes Reportable Pollutant (EPA’s CERCLA’s Section 304): Yes</p> <p><u>Source:</u> (EPA, 2014, 2015, 2016)</p>	Aquatic Life Water Quality Criteria	Aquatic Life Water Quality Guidance Values	Human Health Water Quality Criteria	Freshwater, Chronic (µg/L)	Freshwater, Chronic (µg/L)	Water + Organism (µg/L)	n/a	21,900	1.4
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References	<p>ATSDR. (2014). Toxicological Profile for Trichloroethylene.</p> <p><a href="https://doi.org/http://www.atsdr.cdc.gov/toxprofiles/tp19.pdf">https://doi.org/http://www.atsdr.cdc.gov/toxprofiles/tp19.pdf</a></p> <p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from</p> <p><a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p> <p>EPA. (2014). Priority Pollutant List. Retrieved from</p>									

<https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf>

EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <https://www.epa.gov/epcra/epcracerclaa-ss112r-consolidated-list-lists-march-2015-version>

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SRC. (2013). FatePointers Search Module, PhysProp. Retrieved December 1, 2017, from <http://esc.srcinc.com/fatepointer/search.asp>



Zn

<p>Profile</p>	<p>Classification: Metal</p> <p>CASRN: 7440-66-6</p> <p>Molecular Formula: Zn</p> <p>IUPAC Name: Zinc</p> <p>Synonyms: none</p> <p>Source: (EPA, 2017)</p> <p>Description</p> <p>Zinc occurs naturally in the environment as a metal ore and can be combined with other elements to form zinc compounds (i.e., chloride, oxide, sulfate, and many others). Zinc is found as a bluish/white shiny metal used as a powder and dust for various purposes that is extracted from the earth via mining.</p> <p>Chemical Characteristics</p> <table border="1"> <tr> <td>Molecular Weight (g/mol)</td><td>65</td></tr> <tr> <td>Density (g/cm<sup>3</sup>)</td><td>n/a</td></tr> <tr> <td>Water Solubility (mg/L)</td><td>343,700 @ 25°C</td></tr> <tr> <td>Boiling Point (°C)</td><td>908</td></tr> <tr> <td>Melting Point (°C)</td><td>420</td></tr> <tr> <td>Octanol-water partitioning coefficient (log K<sub>ow</sub>)</td><td>-0.470</td></tr> <tr> <td>Octanol-air partitioning coefficient (log K<sub>oa</sub>)</td><td>-0.501</td></tr> <tr> <td>Organic carbon-water partitioning coefficient (log K<sub>oc</sub>)</td><td>-0.434</td></tr> <tr> <td>Vapor Pressure (mmHg)</td><td>3.87x10<sup>-9</sup> @ 25°C</td></tr> <tr> <td>Henry's Law Constant (atm-m<sup>3</sup>/mol)</td><td>0.0245</td></tr> </table> <p>Sources: (ATSDR, 2005; EPA, 2018; SRC, 2013)</p> <p>Organic Solvents</p> <p>Soluble in acetic acid and alkali but is insoluble in water.</p> <p>Sources: (ATSDR, 2005; NLM, 2017)</p>	Molecular Weight (g/mol)	65	Density (g/cm <sup>3</sup> )	n/a	Water Solubility (mg/L)	343,700 @ 25°C	Boiling Point (°C)	908	Melting Point (°C)	420	Octanol-water partitioning coefficient (log K <sub>ow</sub> )	-0.470	Octanol-air partitioning coefficient (log K <sub>oa</sub> )	-0.501	Organic carbon-water partitioning coefficient (log K <sub>oc</sub> )	-0.434	Vapor Pressure (mmHg)	3.87x10 <sup>-9</sup> @ 25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	0.0245
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Henry's Law Constant (atm-m <sup>3</sup> /mol)	0.0245																				
<p>Sources</p>	<p>Natural Sources</p> <ul style="list-style-type: none"> <li>Natural weathering of zinc-bearing rocks and soil</li> <li>Volcanic dust and gas flux</li> </ul> <p>Non-natural Sources &amp; Uses:</p> <ul style="list-style-type: none"> <li>Mines producing zinc</li> <li>Iron and steel protective coating (i.e., galvanizing, alloys)</li> <li>Paint pigment (zinc chromate)</li> <li>U.S. one cent penny</li> <li>Reducing/precipitating agent in analytical chemistry</li> <li>Dye-casting</li> <li>Construction</li> <li>Electrical components</li> <li>Household goods</li> </ul>																				

	<ul style="list-style-type: none"> <li>• Dental applications (i.e., cement - zinc chloride and zinc phosphate)</li> <li>• Pharmaceuticals (i.e., insulin, vitamins)</li> <li>• Activator in rubber industry (zinc hydroxide)</li> <li>• Ceramics/glass manufacturing</li> <li>• Coated photocopy paper</li> <li>• Wood preservative (zinc chloride and zinc acetate)</li> <li>• Solder fluxes (zinc chloride)</li> <li>• Batteries (zinc chloride)</li> <li>• Smoke bombs, firefighting (zinc chloride)</li> <li>• Fertilizers, disease control (zinc sulfate)</li> <li>• Waterproofing agent (zinc sulfate)</li> </ul> <p><b>Releases to Air</b> Emissions of zinc are reported from production processes and consumptive use, including dust/fumes from mining (including from tailings piles), coal/fuel combustion, refuse incineration, smelters, and electrical power generation. Zinc is emitted to the air naturally from volcanic explosions and forest fires. Zinc is found in air from windborne soil particles, biogenic emissions, and sea salt spray.</p> <p><b>Releases to Soil</b> Releases of zinc to soil are reported from production processes and consumptive use, primarily from smelter slags and wastes, mine tailings, coal and bottom fly ash, and fertilizer discharges. Other sources include vehicle tire debris, releases from hazardous waste sites and landfills, and application of sludge to crops. Natural sources of zinc include atmospheric deposition.</p> <p><b>Releases to Water</b> Releases of zinc to surface waters are reported from production processes and consumptive use, primarily from wastewater treatment plants. Other sources include urban stormwater runoff (i.e., building roofs, plumbing, and vehicles), mine drainage, and industrial wastewater effluent (primarily from iron and steel, zinc smelting, plastics, and electroplating industries). Natural sources of zinc to surface waters include erosion of soil particles. Other sources include releases from hazardous waste sites and landfills.</p> <p><u>Source: (ATSDR, 2005)</u></p>
<p><b>Transport and Fate</b></p>	<p><b>Transformation &amp; Degradation</b> Zinc is found primarily in the +2 oxidation state.</p> <ul style="list-style-type: none"> <li>• In air, zinc may undergo chemical transformation (i.e., oxidation) prior to deposition. Transformations may change the anionic speciation of the compound.</li> <li>• In water, zinc can dissolve in acids/strong bases through hydrolysis. Biomethylation of zinc compounds is not likely to occur. Photolysis does not significantly affect the fate of zinc compounds.</li> <li>• In soil, zinc undergoes reactions through perception/dissolution, complexation/dissociation, and adsorption/desorption (controlled by pH, redox potential, concentration of ions, quantity of sorption sites, and organic ligands present). Cation exchange is influenced by soil acidity (more zinc available in ionic forms in more acidic soils). Bacteria/fungi are capable of oxidizing zinc sulfide to solubilize zinc in soil solution.</li> </ul>

## Partitioning

The transport and partitioning of zinc is dependent on the speciation complex and the environmental media.

- In air, zinc exists primarily in its oxidized form bound to aerosols dependent on the amount emitted. Zinc particles can be transported long distances and undergo dry/wet atmospheric deposition.
- In water, zinc exists as the hydrated form and can form complexes with organic/inorganic ligands, and also bind to humic acid. Zinc can occur in both suspended and dissolved forms in surface water. Zinc can be in the suspended form and also sorb to suspended solids (sediment, clay minerals, organic material) depending on water conditions (sorb at pH >7 and higher salinity). Phosphates and iron hydroxides affect transfer of zinc from water to sediments. Zinc concentrations in water can increase as pH decrease.
- In soil, zinc sorbs strongly to solid particles (soil, sediment, organic matter). Zinc's soil mobility is dependent on soil type and its properties (cation exchange, pH, redox potential, chemical species present) and the speciated form of the element. Soils with high organic matter, pH increases and zinc in solution increases. Zinc is primarily immobile in contaminated soils and leaching to groundwater is slow unless zinc is in its soluble form (i.e., agricultural application and mine tailings). Zinc is more concentrated in sediment than in water column.

## Bioaccumulation/Bioconcentration

Zinc bioconcentrates moderately in aquatic organisms (higher in crustaceans/bivalves than in fish). Zinc does not concentrate in plants and does not biomagnify through the terrestrial food chain. Plants may accumulate zinc if soils are contaminated.

Bioconcentration Factor	Bioaccumulation Factor
4 to 24,000	n/a

Note: BCF reported for fish

Source: (ATSDR, 2005)

## Water Quality Regulations

### Oregon Water Quality Standards

Aquatic Life Water Quality Criteria Freshwater, Chronic (µg/L)	Aquatic Life Water Quality Guidance Values Freshwater, Chronic (µg/L)	Human Health Water Quality Criteria Water + Organism (µg/L)
Calculated as function of hardness	n/a	2,100

Source: (DEQ, 2017)

Priority Pollutant (EPA's Clean Water Act): Yes

TRI-Listed Pollutant (EPA's EPCRA Section 313): Yes

Reportable Pollutant (EPA's CERCLA's Section 304): Yes (only fume, dust, and compounds)

Source: (EPA, 2014, 2015, 2016)

## Abbreviations / Acronyms

atm-m<sup>3</sup>/mol – atmosphere-cubic meters per mole

CASRN – Chemical Abstract Registry Number

CERCLA – Comprehensive Environmental Response, Compensation and Liability Act

	<p>°C – degrees Celsius</p> <p>EPA – Environmental Protection Agency</p> <p>EPCRA – Environmental Planning and Community Right-to-Know Act</p> <p>g/cm<sup>3</sup> – grams per centimeter cubed</p> <p>IUPAC – International Union of Pure and Applied Chemistry</p> <p>L/kg – liters per kilogram</p> <p>log – log base 10 of K (i.e., 10<sup>K</sup>)</p> <p>mm Hg – millimeters mercury</p> <p>mol/L – moles per liter</p> <p>n/a – not available / not analyzed</p> <p>µg/liter – micrograms per liter</p>
References	<p>ATSDR. (2005). Toxicological Profile for Zinc.  <a href="https://doi.org/http://dx.doi.org/10.1155/2013/286524">https://doi.org/http://dx.doi.org/10.1155/2013/286524</a></p> <p>DEQ. (2017). Oregon Water Quality Criteria for Toxic Pollutants Tables 30, 31, 40 (OAR 340-041-8033). Retrieved from  <a href="https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603">https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=235603</a></p> <p>EPA. (2014). Priority Pollutant List. Retrieved from  <a href="https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf">https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf</a></p> <p>EPA. (2015). List of Lists: Consolidated List of Chemicals Subject to the Emergency Planning and Community Right- To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act. Retrieved from <a href="https://www.epa.gov/epcra/epcracerclaa-ss112r-consolidated-list-lists-march-2015-version">https://www.epa.gov/epcra/epcracerclaa-ss112r-consolidated-list-lists-march-2015-version</a></p> <p>EPA. (2016). Toxic Chemical Release Inventory Reporting Forms and Instructions. Retrieved from <a href="https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf">https://ofmpub.epa.gov/apex/guideme_ext/guideme_ext/r/files/static/v3321/rfi/RY_2016_RFI.pdf</a></p> <p>EPA. (2017). Chemistry Dashboard. Retrieved November 1, 2017, from <a href="https://comptox.epa.gov/dashboard">https://comptox.epa.gov/dashboard</a></p> <p>EPA. (2018). Estimation Programs Interface Suite. Retrieved from <a href="https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface# citing">https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface# citing</a></p> <p>NLM. (2017). PubChem Substance and Compound Databases. Retrieved November 1, 2017, from <a href="https://pubchem.ncbi.nlm.nih.gov/">https://pubchem.ncbi.nlm.nih.gov/</a></p> <p>SRC. (2013). FatePointers Search Module, PhysProp. Retrieved December 1, 2017, from <a href="http://esc.srcinc.com/fatepointer/search.asp">http://esc.srcinc.com/fatepointer/search.asp</a></p>