

[New Search](#) [Return to Previous Search Results](#) [Print](#)

Chemical Name: Ammonia
 Chemical Type: Inorganic Chemical Abstracts Service Registry Number: 7664-41-7
 Synonyms: NH3; NH4+ (ammonium)

Source & References	Threshold 1 (ug/L)	Threshold 2 (ug/L)	Units if not ug/L	Notes	Foot note1	Foot note2	Adoption Date	Limiting Threshold
Drinking Water Standards - Maximum Contaminant Levels (MCLs)								
California Dept of Public Health								
Primary MCL (health based + technology & economics)								
Secondary MCL (taste & odor or welfare-based)								
U.S. Environmental Protection Agency (USEPA)								
Primary MCL (health based + technology & economics)								
Secondary MCL (taste & odor or welfare-based)								
MCL Goal (level for no adverse health effects)								
California Public Health Goal or PHG (Cal/EPA, OEHHA)								
California Notification Levels (Department of Public Health)								
Source & References								
Drinking Water Health Advisories or Suggested No-Adverse-Response Levels for non-cancer health effects								
USEPA IRIS Reference Dose (RfD) as a drinking water level*								
USEPA Health Advisory	30000				68		1/1/1992	TH G;IS
National Academy of Sciences Health Advisory								
One-in-a-Million Incremental Cancer Risk Estimates for Drinking Water								
Cal/EPA Cancer Potency Factor as a drinking water level**								
USEPA Integrated Risk Information System (IRIS)								
USEPA Health Advisory					D	68	1/1/1992	
National Academy of Sciences Health Advisory								
California Proposition 65 Safe Harbor Level as a drinking water level***								
No Significant Risk Level (one-in-100,000 cancer risk)								
Maximum Allowable Dose Level for Reproductive Toxicity								
Source & References								
Taste & Odor Threshold								
	1500				126		1/1/1983	TO G;IS
Agricultural Water Quality Goals (Food & Ag. Org. of United Nations)								
California Inland Surface Waters - California Toxics Rule Criteria (USEPA)								
Human Health Protection (30-day average)								
Sources of Drinking Water (water & fish consumption)								
Other waters (fish consumption only)								
Freshwater Aquatic Life Protection								
Continuous Concentration (4-day Average)								

Source & References	Threshold 1 (ug/L)	Threshold 2 (ug/L)	Units if not ug/L	Notes	Foot note1	Foot note2	Adoption Date	Limiting Threshold
Maximum Concentration (1-hour Average)								
Maximum (Instantaneous)								
California Enclosed Bays & Estuaries - California Toxics Rule Criteria (USEPA)								
Human Health Protection (30-day avg; fish consumption only)								
Saltwater Aquatic Life Protection								
Continuous Concentration (4-day Average)								
Maximum Concentration (1-hour Average)								
Maximum (Instantaneous)								
California Ocean Plan -- Numerical Water Quality Objectives (State Water Board)								
Human Health Protection (30-day average; fish consumption only)								
Marine Aquatic Life Protection								
6- month Median	600				89			
30-day Average								
7-day Average								
Daily Maximum	2400				89			
Instantaneous Maximum	6000				89			
Source & References	Threshold 1 (ug/L)	Threshold 2 (ug/L)	Units if not ug/L	Notes	Foot note1	Foot note2	Adoption Date	Limiting Threshold
National Recommended Water Quality Criteria (U.S. Environmental Protection Agency; CA Dept of Fish and Game if footnoted)								
Human Health & Welfare Protection								
Public Health Effects (other than cancer risk)								
Water & Fish Consumption								
Fish Consumption Only								
One-in-a-Million Incremental Cancer Risk Estimate								
Water & Fish Consumption								
Fish Consumption Only								
Taste & Odor or Welfare								
Freshwater Aquatic Life Protection								
Recommended Criteria								
Continuous Concentration (4-day Average)				see page 17				TA IS
24-hour Average								
Maximum Concentration (1-hour Average)				see page 17				TA IS
Maximum (Instantaneous)								
Toxicity Information (Lowest Observed Effect Level)								
Acute								
Chronic								
Other								
Saltwater Aquatic Life Protection								
Recommended Criteria								
Continuous Concentration (4-day Average)	35			see page 18	112			
24-hour Average								
Maximum Concentration (1-hour Average)	233			see page 18	112			
Maximum (Instantaneous)								
Toxicity Information (Lowest Observed Effect Level)								
Acute								

Chronic									
Other									
Source & References	Threshold 1 (ug/L)	Threshold 2 (ug/L)	Units if not ug/L	Notes	Foot note1	Foot note2	Adoption Date	Limiting Threshold	

Notes:

- * Assumes 70 kg body weight, 2 liters/day water consumption, and 20% relative source contribution from drinking water. An additional uncertainty factor of 10 is used for Class C carcinogens.
- ** Assumes 70 kg body weight and 2 liters/day water consumption.
- *** Regulatory dose level divided by 2 liters/day water consumption.
- # Carcinogen / based on cancer risk
- R Reproductive toxin / based on reproductive toxicity.
- CA First threshold or range is recommended to implement promulgated Criteria to protect Aquatic life.
- CH First threshold or range is recommended to implement promulgated Criteria to protect Human health.
- CC First threshold or range is recommended to implement the Chemical Constituents objective.
- CT First threshold or range is recommended to implement the Chemical Constituents and the Tastes & Odors objectives.
- TA First threshold or range is recommended to implement the Toxicity objective to protect Aquatic life.
- TH First threshold or range is recommended to implement the Toxicity objective to protect Human health.
- TO First threshold or range is recommended to implement the Tastes and Odors objectives.
- G Limiting threshold applies to Groundwater only.
- IS Limiting threshold applies to Inland Surface water only.
- G&IS Limiting threshold applies to both Groundwater and Inland Surface water.
- EW Limiting threshold applies to Estuarine Water only.
- MW Limiting threshold applies to Marine Water only.

Footnotes

- 68 Draft / tentative / provisional; applies only to second value if two separate values are listed; applies to range if a range of values is listed.
- D Class D: Not classifiable as to human carcinogenicity; no data or inadequate evidence. Inadequate information to assess carcinogenic potential (U.S. Environmental Protection Agency, 1986 Guidelines for Carcinogen Risk Assessment).
- 126 Applies to second value if more than one value listed. Water-dilution odor threshold calculated from air odor threshold using equilibrium distributions. From Reference 29.
- 89 Expressed as nitrogen.
- 112 Listed criterion expressed as unionized ammonia; criteria based on total ammonia are shown on Page 18.

[New Search](#) [Return to Previous Search Results](#) [Print](#)

[Back to Top of Page](#)

TYPES OF NUMERIC WATER QUALITY THRESHOLDS

Drinking Water Standards -

Maximum Contaminant Levels (MCLs)

MCLs are drinking water standards adopted by the California Department of Public Health (CDPH) pursuant to the California Safe Drinking Water Act. California MCLs may be found in Title 22 of the California Code of Regulations (CCR), Division 4, Chapter 15, *Domestic Water Quality and Monitoring*. The U.S. Environmental Protection Agency (USEPA) also adopts MCLs under the federal Safe Drinking Water Act. CDPH drinking water standards are required to be at least as stringent as those adopted by the USEPA. If USEPA adopts a federal MCL that is lower than the corresponding state MCL, the state is required by statute to revise its MCL to at least as low as the federal MCL. Some California MCLs are also more stringent than federal MCLs.

Primary MCLs are derived from health-based criteria (by USEPA from MCL Goals; by CDPH from Public Health Goals or from one-in-a-million [10⁻⁶] incremental cancer risk estimates for carcinogens and threshold toxicity levels for non-carcinogens). MCLs also include technologic and economic considerations based on the feasibility of achieving and monitoring for these concentrations in drinking water supply systems and at the tap. It should be noted that the balancing of health effects with technologic and economic considerations in the derivation of MCLs may not be appropriate for protection of the quality of raw surface water or groundwater resources. **Secondary MCLs** are derived from human welfare considerations (e.g., taste, odor, laundry staining) in the same manner as Primary MCLs.

Drinking water MCLs are directly applicable to water supply systems and at the tap and are enforceable by CDPH and local health departments. California MCLs, both Primary and Secondary, are directly applicable to groundwater and surface water resources when they are specifically referenced as water quality objectives in the pertinent *Water Quality Control Plan (or Basin Plan)*. Where fully health protective, MCLs may also be used to interpret narrative water quality objectives prohibiting toxicity to humans in water designated as a source of drinking water (municipal and domestic supply) in the *Water Quality Control Plan*.

MCL Goals are promulgated by USEPA as part of the National Primary Drinking Water Regulations. MCL Goals represent the first step in establishing federal Primary MCLs and are required by federal statute to be set at levels that represent no adverse health risks. They are set at "zero" for known and probable human carcinogens, since theoretically a single molecule of such a chemical could present some degree of cancer risk. Threshold levels posing no risk of health effects are used for non-carcinogens and for possible human carcinogens. Because they are purely health-based, non-zero MCL Goals may be useful in interpreting narrative water quality objectives which prohibit toxicity to human consumers.

References:

1. California Department of Public Health, *California Code of Regulations*, Title 22, Division 4, Chapter 15, Chapter 15.5, *Disinfectant Residuals, Disinfection Byproducts, and Disinfection Precursors*, Chapter 17, *Lead and Copper*, <http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Lawbook.aspx>.
2. U.S. Environmental Protection Agency, Title 40, *Code of Federal Regulations*, Parts 141 [Primary MCLs] and 143 [Secondary MCLs], <http://water.epa.gov/drink/contaminants/index.cfm>.
3. U.S. Environmental Protection Agency, Office of Water, *2011 Edition of the Drinking Water Standards and Health Advisories tables* (January 2011) EPA 820-R-11-002, http://water.epa.gov/action/advisories/drinking/drinking_index.cfm.
4. U.S. Environmental Protection Agency, Region 9, Drinking Water Office, *Drinking Water Standards and Health Advisories Table* (November 2009), <http://www.epa.gov/region09/water/drinking/>.
5. California Department of Public Health, Division of Drinking Water and Environmental Management, *Maximum Contaminant Levels and Regulation Dates for Drinking Water, U.S. EPA vs California*, <http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Chemicalcontaminants.aspx>.
7. U.S. Environmental Protection Agency, Office of Water, *National Primary Drinking Water Regulations, Contaminant Specific Fact Sheets - Technical Version* (October 1995) <http://www.epa.gov/nscep/index.html> or <http://water.epa.gov/drink/contaminants/basicinformation/index.cfm>.

California Public Health Goals (PHGs)

The California Safe Drinking Water Act of 1996 requires the Cal/EPA, Office of Environmental Health Hazard Assessment (OEHHA) to perform risk assessments and to adopt Public Health Goals for contaminants in drinking water based exclusively on public health considerations. PHGs represent levels of contaminants in drinking water that would pose no significant health risk to individuals consuming the water on a daily basis over a lifetime. For carcinogens, PHGs are based on 10⁻⁶

incremental cancer risk estimates. OEHHA and the California Department of Health Services (DHS) consider the 10⁻⁶ risk level to represent a *de minimis* level of cancer risk for involuntary exposure to contaminants in drinking water. For other contaminants, PHGs are based on threshold toxicity limits, with a margin of safety.

PHGs adopted by OEHHA are for use by the DHS in establishing primary drinking water MCLs. Where PHGs are to be based solely on scientific and public health considerations without regard to economic considerations, drinking water MCLs are to consider economic factors and technical feasibility. Each MCL adopted by DHS is to be set at a level that is as close as feasible to the corresponding PHG, placing emphasis on the protection of public health. Being purely health-based, PHGs are also appropriate to use in interpreting narrative toxicity objectives with respect to human exposures from constituents in waters that have been designated as existing or potential sources of municipal and domestic supply. In addition, where water quality objectives require compliance with drinking water MCLs, the PHGs may provide an indication as to whether MCLs are likely to be revised upward or downward in the future. This information is important because the State and Regional Water Boards must ensure the usability of water for the foreseeable future.

Reference:

10. California Environmental Protection Agency (Cal/EPA), Office of Environmental Health Hazard Assessment, *Public Health Goals for Chemicals in Drinking Water* (various dates), <http://www.oehha.org/water/phg>.

California Notification and Response Levels

Notification levels (formerly called "action levels") are published by the California Department of Public Health (CDPH) for chemicals for which there is no drinking water MCL. Notification levels are based mainly on health effects -- in most cases an incremental cancer risk estimate of 10⁻⁶ for carcinogens and a threshold toxicity limit for other constituents. As with MCLs, the ability to quantify the amount of the constituent in a water sample using readily available analytical methods may cause notification levels to be set at somewhat higher concentrations than purely health-based values. Notification levels are advisory to water suppliers. If a notification level is exceeded, local government notification is required and customer notification is recommended. At a higher level, called the response level, the drinking water source is recommended to be taken out of service.

Reference:

35. California Department of Public Health, Division of Drinking Water and Environmental Management, *Drinking Water Notification Levels*, <http://www.cdph.ca.gov/certlic/drinkingwater/Pages/NotificationLevels.aspx>.

Drinking Water Health Advisories and Suggested No-Adverse-Response Levels

The U.S. Environmental Protection Agency (USEPA), Office of Research and Development, National Center for Environmental Assessment maintains a chemical database called the Integrated Risk Information System (IRIS). IRIS contains USEPA's most current information on human health effects that may result from exposure to toxic substances found in the environment. One type of criteria presented in IRIS, reference doses (RfDs) are calculated as safe exposure levels for non-cancer health effects. They are presented in units of milligrams of chemical per kilogram body weight per day of exposure (mg/kg-day). RfDs may be converted into concentrations in drinking water (ug/L) using standard exposure assumptions, including 70 kg body weight, 2 liters per day water consumption rate and a relative source contribution from drinking water of 20 percent.

Health Advisories are published by USEPA for short-term (1-day exposure or less or 10-day exposure or less), long-term (7-year exposure or less), and lifetime human exposures through drinking water. Health advisories for non-carcinogens and for possible human carcinogens are calculated for chemicals where sufficient toxicologic data exist.

Suggested No-Adverse-Response Levels (SNARLs) are human health-based criteria that were published by the National Academy of Sciences (NAS) in the nine volumes of *Drinking Water and Health* (1977 to 1989). USEPA health advisories were also formerly published as "SNARLs." SNARLs do not reflect the cancer risk that may be posed by chemical exposure. NAS criteria from *Drinking Water and Health* may not contain the most recent toxicologic information. They should only be used to interpret narrative water quality objectives where more recent health-based criteria are absent.

References:

3. U.S. Environmental Protection Agency, Office of Water, *2011 Edition of the Drinking Water Standards and Health Advisories tables* (January 2011), EPA 820-R-11-002, http://water.epa.gov/action/advisories/drinking/drinking_index.cfm

4. U.S. Environmental Protection Agency, Region 9, Drinking Water Office, *Drinking Water Standards and Health Advisories Table* (November 2009), <http://www.epa.gov/region09/water/drinking/>.

6. U.S. Environmental Protection Agency, *Integrated Risk Information System* [IRIS] database, <http://www.epa.gov/iris>.
11. U.S. Environmental Protection Agency, Office of Drinking Water, Health Advisory documents; or Office of Water, *Drinking Water Health Advisory* documents (various dates), http://water.epa.gov/action/advisories/drinking/drinking_index.cfm.
12. National Academy of Sciences, *Drinking Water and Health*, Vol.1 (1977), Vol. 3 (1980), Vol. 4 (1982), Vol. 5 (1983), Vol. 6 (1986), and Vol. 7 (1987), <http://www.nap.edu>.
13. U.S. Environmental Protection Agency, Water Quality Advisory documents (various dates), <http://www.epa.gov/nscep/index.html>.
33. U.S. Environmental Protection Agency, Office of Water, *Drinking Water Advisory: Consumer Acceptability Advice and Health Effects Analysis* documents (various dates), http://water.epa.gov/action/advisories/drinking/drinking_index.cfm.
34. U.S. Environmental Protection Agency, Office of Research and Development, Oral Reference Doses and Oral Slope Factors for JP-4, JP-5, Diesel fuel, and Gasoline, memorandum from Joan Dollarhide to Carol Sweeney, Region X (24 March 1992).
36. U.S. Environmental Protection Agency, Office of Pesticide Programs, Registration Eligibility Decision (RED) Documents, <http://www.epa.gov/pesticides/reregistration/status.htm>.

One-in-a-Million Incremental Cancer Risk Estimates for Drinking Water

For chemicals that are associated with causing cancer, the risk of an effect is considered to be proportional to the amount or dose of the chemical to which a population is exposed. For each carcinogen, risk and dose are related by a cancer potency factor (often abbreviated $q1^*$) which is equal to the risk of getting cancer per unit dose of the chemical. The potency factor is expressed in units of inverse milligrams of chemical per kilogram body weight per day of exposure (mg/kg-day)⁻¹. Potency factors for carcinogens are calculated by extrapolation from dose-response relationships often developed in laboratory animal exposure studies. For a few chemicals (e.g., arsenic), they are based on human epidemiologic data. Potency factors may be found in the California Environmental Protection Agency (Cal/EPA) *Toxicity Criteria Database*, the U.S. Environmental Protection Agency (USEPA) *Integrated Risk Information System* (IRIS) database, USEPA health advisory documents, and the *Drinking Water and Health* publications of the National Academy of Sciences (NAS). If one assumes a drinking water consumption rate of 2 liters per day and an average human body weight of 70 kg, the concentration in drinking water associated with a particular degree of cancer risk may be directly calculated.

There is often confusion as to which cancer risk level should be used in selecting human health-based criteria to interpret the narrative water quality objectives. The one-in-a-million (10⁻⁶) incremental cancer risk level has historically formed the basis of human health protective numerical water quality thresholds in California. It is generally recognized by California and federal agencies as the *de minimis* level of risk associated with involuntary exposure to toxic chemicals in environmental media. USEPA-promulgated water quality criteria applicable to California surface waters pursuant to the federal Clean Water Act are required to be implemented at the 10⁻⁶ risk level. The 10⁻⁶ risk level has long formed the basis of water-related health-protective regulatory decision-making in California. For consistency, the 10⁻⁶ risk level should govern the selection of human health-based criteria to interpret narrative toxicity objectives.

Cal/EPA Cancer Potency Factor - The Office of Environmental Health Hazard Assessment (OEHHA) has lead responsibility within Cal/EPA for the assessment of human health risks associated with exposures to toxic substances in environmental media. OEHHA also performs health risk assessments for California state agencies outside Cal/EPA, such as the development of Public Health Goals (PHGs) for use in deriving drinking water standards by the Department of Health Services. OEHHA maintains an on-line database of health risk information for chemicals called the Toxicity Criteria Database. The health based criteria presented in this database have been used as a basis for California state regulatory actions. The majority of these criteria has undergone peer review and in many cases rigorous regulatory review. The database includes cancer potency factors for inhalation and oral exposures to many chemicals. These Cal/EPA cancer potency factors may be used to calculate concentrations in drinking water associated with specific cancer risk levels, using standard exposure assumptions of 2 liters per day water consumption and 70 kg body weight.

USEPA Integrated Risk Information System (IRIS) - The U.S. Environmental Protection Agency (USEPA) Office of Research and Development, National Center for Environmental Assessment maintains a chemical database called the Integrated Risk Information System. IRIS contains USEPA's most current information on human health effects that may result from exposure to toxic substances found in the environment. One type of criteria presented in IRIS concentrations of chemicals in drinking water that would be associated with specific levels of cancer risk.

Health Advisories published by USEPA contain incremental cancer risk estimates for known and

probable human carcinogens.

Suggested No-Adverse-Response Levels are human health-based criteria that were published by the National Academy of Sciences (NAS) in the nine volumes of *Drinking Water and Health* (1977 to 1989). USEPA's health advisories were also formerly published as "SNARLs." Incremental cancer risk estimates for carcinogens are presented in these NAS and USEPA documents. NAS criteria from *Drinking Water and Health* may not contain the most recent toxicologic information. They should only be used to interpret narrative water quality objectives where more recent health-based criteria are absent.

References:

3. U.S. Environmental Protection Agency, Office of Water, *2011 Edition of the Drinking Water Standards and Health Advisories table* (January 2011), EPA 820-R-11-002, http://water.epa.gov/action/advisories/drinking/drinking_index.cfm.
4. U.S. Environmental Protection Agency, Region 9, Drinking Water Office, *Drinking Water Standards and Health Advisories Table* (November 2009), <http://www.epa.gov/region09/water/drinking/>.
6. U.S. Environmental Protection Agency, *Integrated Risk Information System [IRIS] database*, <http://www.epa.gov/iris>.
11. U.S. Environmental Protection Agency, Office of Drinking Water, *Health Advisory documents*; or Office of Water, *Drinking Water Health Advisory documents* (various dates), http://water.epa.gov/action/advisories/drinking/drinking_index.cfm
12. National Academy of Sciences, *Drinking Water and Health*, Vol. 1 (1977), Vol. 3 (1980), Vol. 4 (1982), Vol. 5 (1983), Vol. 6 (1986), and Vol. 7 (1987), <http://www.nap.edu>.
13. U.S. Environmental Protection Agency, *Water Quality Advisory documents* (various dates). <http://www.epa.gov/nscep/index.html>.
18. Cal/EPA, Office of Environmental Health Hazard Assessment, *California Environmental Protection Agency Toxicity Criteria Database*, <http://www.oehha.org/risk/ChemicalDB/index.asp>.
31. Cal/EPA, Office of Environmental Health Hazard Assessment, *Air Toxics Hot Spots Program Risk Assessment Guidelines: Part II - Technical Support Document for Describing Available Cancer Potency Factors* (May 2009), http://www.oehha.ca.gov/air/hot_spots/tsd052909.html
36. U.S. Environmental Protection Agency, Office of Pesticide Programs, *Registration Eligibility Decision (RED) Documents*, <http://www.epa.gov/pesticides/reregistration/status.htm>.

Proposition 65 Safe Harbor Levels

Safe harbor levels are established pursuant to the California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65) for known human carcinogens and reproductive toxins. Proposition 65, an initiative statute, made it illegal to expose persons to significant amounts of these chemicals without prior notification or to discharge significant amounts of these chemicals to sources of drinking water. These "significant amounts" are the safe harbor levels adopted by the Office of Environmental Health Hazard Assessment (OEHHA) in regulations contained in Title 22 of the California Code of Regulations (CCR), Division 2, Chapter 3. The intent of Proposition 65 was not to establish levels in water that are considered to be "safe."

For carcinogens, No-Significant-Risk Levels (NSRLs) are set at concentrations associated with a one-in-100,000 (10⁻⁵) incremental risk of cancer. These are the only California health based limits derived from risk levels greater than 10⁻⁶. As such, they are not as protective of human health as many other published criteria. For reproductive toxicants, Maximum Allowable Dose Levels are set at 1/1000 of the no-observable-effect level (NOEL).

Proposition 65 levels are doses, expressed in units of micrograms per day of exposure (ug/day). Dose levels may be converted into concentrations in water by assuming 2 liters per day water consumption and 100 percent exposure to the chemical through drinking water, under regulations contained in Title 22 of CCR, Sections 12721 and 12821.

References:

14. Cal/EPA, Office of Environmental Health Hazard Assessment, *California Code of Regulations, Title 27, Division 4, Chapter 1*, <http://www.oehha.org/prop65.html>.
15. Cal/EPA, Office of Environmental Health Hazard Assessment, *Proposition 65 No Significant Risk Levels and Maximum Allowable Dose Levels*, <http://www.oehha.org/prop65/getNSRLs.html>.

Taste and Odor Thresholds

Consumers of water do not want to drink water that tastes or smells bad. Therefore, water that contains substances in concentrations that cause adverse tastes or odors may be considered to be impaired with respect to beneficial uses associated with drinking water use (municipal or domestic supply). Adverse tastes and odors may also be associated with nuisance conditions. Taste and odor thresholds are used to translate narrative water quality objectives that prohibit adverse tastes and odors in waters of the State and prohibit nuisance conditions. Taste and odor thresholds form the

basis for many secondary drinking water Maximum Contaminant Levels (MCLs) and are also published by the U.S. Environmental Protection Agency in the National Recommended Water Quality Criteria. The values listed here are from sources other than those listed above.

References:

3. U.S. Environmental Protection Agency, Office of Water, *2011 Edition of the Drinking Water Regulations and Health Advisories tables* (January 2011), EPA 820-R-11-002, http://water.epa.gov/action/advisories/drinking/drinking_index.cfm.
7. U.S. Environmental Protection Agency, Office of Water, *National Primary Drinking Water Regulations, Contaminant Specific Fact Sheets - Technical Version* (October 1995), <http://www.epa.gov/nscep/index.html> or <http://water.epa.gov/drink/contaminants/basicinformation/index.cfm>.
8. U.S. Environmental Protection Agency, *Federal Register*, Vol. 54, No. 97 (Mon., 22 May 1989), pp. 22138, 22139.
10. California Environmental Protection Agency (Cal/EPA), Office of Environmental Health Hazard Assessment, *Public Health Goals for Chemicals in Drinking Water* (various dates), <http://www.oehha.org/water/phg>.
11. U.S. Environmental Protection Agency, Office of Drinking Water, *Health Advisory* documents; or Office of Water, *Drinking Water Health Advisory* documents (various dates). Earlier documents were called "Suggested No-Adverse Response Levels", http://water.epa.gov/action/advisories/drinking/drinking_index.cfm.
29. J.E. Amore and E. Hautala, *Odor as an Aid to Chemical Safety: Odor Thresholds Compared with Threshold Limit Values and Volatilities for 214 Industrial Chemicals in Air and Water Dilution*, *Journal of Applied Toxicology*, Vol. 3, No. 6, pages 272-290 (1983), [http://onlinelibrary.wiley.com/journal/10.1002/\(ISSN\)1099-1263](http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1099-1263).
30. California State Water Resources Control Board, *Water Quality Criteria*, McKee & Wolf (1963, 1978), http://www.waterboards.ca.gov/publications_forms/publications/general/index.shtml.
33. U.S. Environmental Protection Agency, Office of Water, *Drinking Water Advisory: Consumer Acceptability Advice and Health Effects Analysis* documents (various dates), http://water.epa.gov/action/advisories/drinking/drinking_index.cfm.

Agricultural Water Quality Goals

Water Quality for Agriculture, published by the Food and Agriculture Organization of the United Nations in 1985, contains criteria protective of various agricultural uses of water, including irrigation of various types of crops and stock watering. At or below the thresholds presented in the Water Quality Goals database, agricultural uses of water should not be limited. These criteria may be used to translate narrative water quality objectives for chemical constituents that prohibit chemicals in concentrations that would impair agricultural uses of water.

Reference:

16. U.S. Environmental Protection Agency, *Quality Criteria for Water*, 1986 (May 1986) [The Gold Book], <http://www.epa.gov/waterscience/criteria/goldbook.pdf>, plus updates (various dates), <http://water.epa.gov/scitech/swguidance/standards/criteria/>.
19. Ayers, R. S. and D. W. Westcot, *Water Quality for Agriculture*, Food and Agriculture Organization of the United Nations - Irrigation and Drainage Paper No. 29, Rev. 1, Rome (1985) <http://www.fao.org/DOCREP/003/T0234E/T0234E00.htm>.

California Toxics Rule (CTR) Criteria

The federal Clean Water Act requires all states to have enforceable numerical water quality criteria applicable to priority toxic pollutants in surface waters. California lacked many of these standards, in part due to the State Water Board's repeal of the Inland Surface Waters Plan and Enclosed Bays and Estuaries Plan, resulting from a legal challenge. In May 2000, the U.S. Environmental Protection Agency (USEPA) promulgated water quality criteria for priority toxic pollutants for California's inland surface waters and enclosed bays and estuaries in federal regulations called the "California Toxics Rule." Included are criteria to protect both human health and aquatic life, similar to those published in the National Recommended Water Quality Criteria, discussed below. The human health criteria are derived for drinking water sources (those designated in Basin Plans as municipal and domestic supply or MUN) considering exposure from consumption of both water and fish that had lived in the water. For waters that are not drinking water sources (non-MUN waters), human health criteria consider contaminated fish consumption only. Freshwater and saltwater aquatic life criteria are included for multiple averaging periods to protect against both acute and chronic toxicity. The California Toxics Rule reiterated several criteria that USEPA had promulgated in December 1992 for California waters and those of other states in the National Toxics Rule (NTR).

The CTR and NTR criteria, along with the beneficial use designations in the Basin Plans, are directly

applicable water quality standards for these toxic pollutants in these waters under Section 304(c) of the federal Clean Water Act. Implementation provisions for these standards have been provided in the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SWRCB Resolution No. 2000-015), adopted by the State Water Board in March 2000. The policy includes time schedules for compliance, provisions for mixing zones, analytical methods and reporting levels.

CTR and NTR criteria presented for inland surface waters include both types of human health criteria and freshwater aquatic life criteria. CTR and NTR criteria presented for enclosed bays and estuaries include non-MUN human health criteria and saltwater aquatic life criteria.

References:

17. U.S. Environmental Protection Agency, Federal Register, Volume 65, No. 97 (Thursday, 18 May 2000), pp. 31682-31719 [California Toxics Rule]; and Federal Register, Volume 66, No. 30 (Tuesday, 13 February 2001), pp. 9960-9962 [California Toxics Rule Correction] <http://www.gpoaccess.gov/fr/>.
21. U.S. Environmental Protection Agency, Federal Register, Volume 64, No. 216, (Tuesday, 9 November 1999), pp. 61182-91196 [National Toxics Rule revisions] <http://www.gpoaccess.gov/fr/>.
22. U.S. Environmental Protection Agency, Federal Register, Volume 57, No. 246 (Tuesday, 22 December 1992), pp. 60848-60923 [National Toxics Rule].
23. U.S. Environmental Protection Agency, Federal Register, Volume 60, No. 86, (Thursday, 4 May 1995), pp. 22228-22237 [National Toxics Rule revisions], <http://www.gpoaccess.gov/fr/>.
27. California State Water Resources Control Board, Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (24 February 2005), http://www.waterboards.ca.gov/plans_policies/.

California Ocean Plan

The *Water Quality Control Plan for Ocean Waters of California* (the California Ocean Plan), adopted by the State Water Resources Control Board, includes numerical water quality objectives to protect both human health and marine aquatic life from constituents in marine waters of California. When combined with beneficial use designations, these objectives become directly applicable water quality standards pursuant to Section 304(c) of the federal Clean Water Act. Human health objectives assume exposure via ingestion of fish that lived in water containing the constituent of concern. Marine aquatic life objectives are included for multiple averaging periods to protect against acute and chronic toxic effects.

Reference:

28. California State Water Resources Control Board, *2005 California Ocean Plan: Water Quality Control Plan for Ocean Waters of California* (15 September 2009), http://www.waterboards.ca.gov/water_issues/programs/ocean/.

National Recommended Water Quality Criteria

These criteria, formerly called the National Ambient Water Quality Criteria, are developed by the U.S. Environmental Protection Agency (USEPA) under Section 304(a) of the federal Clean Water Act to provide guidance to the states in developing water quality standards under Section 304(c) of the Act and to interpret narrative toxicity standards (water quality objectives in California). These criteria are designed to protect human health and welfare and aquatic life from pollutants in freshwater and marine surface waters.

The human health protective criteria assume two different exposure scenarios. For waters that are sources of drinking water, exposure is assumed both from drinking the water and consuming aquatic organisms (fish and shellfish) that live in the water. For waters that are not sources of drinking water, exposure is assumed to be from the consumption of aquatic organisms only. Aquatic organisms are known to bioaccumulate certain toxic pollutants in their tissues, so as to magnify human exposures. Because these human health based criteria assume exposure through fish and shellfish consumption, they should not be used to interpret water quality objectives for groundwater where human exposure would only occur from municipal and domestic supply uses. The criteria also include threshold health protective criteria for non-carcinogens. Incremental cancer risk estimates for carcinogens are presented at a variety of risk levels. Organoleptic (taste- and odor-based) levels are also provided for some chemicals to protect human welfare. Some organoleptic criteria are based on adverse taste or odor of chemicals in water, while others are based on the tainting of the flesh of fish and shellfish from chemicals in ambient water.

National Recommended Water Quality Criteria also include criteria that are intended to protect freshwater and saltwater aquatic life. Normally, two types of thresholds are presented for each. Criteria Maximum Concentrations (CMCs) protect aquatic organisms from acute exposures (expressed as 1-hour average or instantaneous maximum concentrations) to pollutants. Criteria Continuous Concentrations (CCCs) are intended protect aquatic organisms from chronic exposures (expressed as

4-day or 24-hour average concentrations). To be able to derive these criteria, the USEPA method requires toxicity data for species representing a minimum of eight families of organisms, including coverage of both vertebrate and invertebrate species. Important aquatic plant species are also considered. Fundamental to the method is protection of all species, even at sensitive life stages, for which there are reliable measurements in the data set. Criteria derived by this method are also intended to protect species for which those in the data set serve as surrogates. Toxicity information, in the form of lowest observed effect levels, is often presented in the USEPA criteria documents where there is insufficient toxicologic information with which to develop recommended criteria.

The National Recommended Water Quality Criteria are found in a number of USEPA documents:

• Quality Criteria for Water, 1986, with updates in 1986 and 1987, also known as the "Gold Book";

• Ambient Water Quality Criteria volumes on specific pollutants or classes of pollutants (beginning in 1980);

• Quality Criteria for Water (1976), also known as the "Red Book";

• Water Quality Criteria, 1972, also known as the "Blue Book."

In December 1992, USEPA promulgated the National Toxics Rule, which updated many of these criteria and made them directly applicable standards for surface waters in many states, including some California waters. These regulations, found in 40 CFR Section 131.36, specify that "[t]he human health criteria shall be applied at the State-adopted 10-6 risk level" for California. To ascertain compliance with the aquatic life protective criteria for metallic constituents, water quality samples were to be analyzed for "total recoverable" concentrations. In May 1995, USEPA amended these regulations to convert most of these aquatic life criteria to dissolved concentrations. Approximately every two years, USEPA publishes a summary of National Recommended Water Quality Criteria.

The California Department of Fish and Game have also published Hazard Assessments and Water Quality Criteria for several pesticide chemicals. These documents contain criteria that are protective of aquatic life. USEPA methods are used to derive these criteria.

References:

9. U.S. Environmental Protection Agency, Quality Criteria for Water (1976) [The Red Book]. <http://www.epa.gov/waterscience/criteria/redbook.pdf>.
13. U.S. Environmental Protection Agency, Water Quality Advisory documents (various dates).
16. U.S. Environmental Protection Agency, Quality Criteria for Water, 1986 (May 1986) [The Gold Book] <http://www.epa.gov/waterscience/criteria/goldbook.pdf>, plus updates (various dates) <http://water.epa.gov/scitech/swguidance/standards/criteria/>.
20. U.S. Environmental Protection Agency, Water Quality Criteria, 1972 (1973) [The Blue Book]. <http://www.epa.gov/nscep/index.html>.
21. U.S. Environmental Protection Agency, Federal Register, Volume 64, No. 216, (Tuesday, 9 November 1999), pp. 61182-91196 [National Toxics Rule revisions] <http://www.gpoaccess.gov/fr/>.
22. U.S. Environmental Protection Agency, Federal Register, Volume 57, No. 246 (Tuesday, 22 December 1992), pp. 60848-60923 [National Toxics Rule].
23. U.S. Environmental Protection Agency, Federal Register, Volume 60, No. 86, (Thursday, 4 May 1995), pp. 22228-22237 [National Toxics Rule revisions], <http://www.gpoaccess.gov/fr/>.
24. U.S. Environmental Protection Agency, National Ambient Water Quality Criteria and National Recommended Water Quality Criteria documents (various dates), <http://water.epa.gov/scitech/swguidance/standards/criteria/index.cfm>.
25. U.S. Environmental Protection Agency, Office of Water, Aquatic Life Ambient Freshwater Quality Criteria - Copper, 2007 Revision, EPA-822-R-07-001 (February 2007), <http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/pollutants/copper/index.cfm>.
26. U.S. Environmental Protection Agency, Office of Water, National Recommended Water Quality Criteria (2009), <http://water.epa.gov/scitech/swguidance/standards/current/index.cfm>.
32. California Department of Fish and Game, Office of Spill Prevention and Emergency Response, Hazard Assessment and Water Quality Criteria documents for pesticides (various dates) <http://www.cdpr.ca.gov/docs/emon/surfwttr/hazasm.htm>.