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STAFF REPORT

THE DESIGNATED LEVEL METHODOLOGY FOR WASTE CLASSIFICATION AND CLEANUP LEVEL DETERMINATION

October 1986

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CALIFORNIA REGIONAL
WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

STATE OF CALIFORNIA

REGIONAL WATER QUALITY CONTROL BOARD • CENTRAL VALLEY REGION

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THE DESIGNATED LEVEL METHODOLOGY FOR WASTE CLASSIFICATION AND CLEANUP LEVEL DETERMINATION

A Summary of the Staff Report of the
California Regional Water Quality Control Board, Central Valley Region

Prepared by Jon B. Marshack, D. Env.

INTRODUCTION

Improper waste management practices and sites which have been contaminated with toxic substances pose significant threats to the quality of California's usable ground and surface water resources. This paper summarizes a staff report of the California Regional Water Quality Control Board, Central Valley Region entitled "The Designated Level Methodology for Waste Classification and Cleanup Level Determination" which, from a water quality perspective, establishes a framework for 1) classifying wastes so that appropriate disposal practices may be selected, and 2) determining the degree to which a contaminated site should be cleaned or to which remedial action is necessary ["how clean is clean"]. The report also shows how these two decision-making processes are related.

In California, the classification of wastes and the establishment of cleanup levels for sites which have been contaminated with toxic chemicals are performed by two separate State agencies with separate regulatory authority. The Department of Health Services (DHS) classifies wastes as 'hazardous' or 'restricted hazardous' and sets site cleanup/mitigation criteria based on a direct threat of these wastes or sites to public health. The State Water Resources Control Board together with the nine Regional Water Quality Control Boards classify wastes as 'designated', 'nonhazardous solid', or 'inert' and determine cleanup levels based on the threat that wastes and contaminated sites pose to the beneficial uses of waters of the State, as required by the Porter-Cologne Water Quality Control Act (contained in Division 7 of the California Water Code) and policies set forth by the Boards.

WASTE CLASSIFICATION

As shown in Figures 1 and 2, California regulations divide wastes into five categories which, in turn, determine the classes of waste management units to which their discharge is permitted. Detailed criteria are contained in Title 22 of the California Code of Regulations (CCR), Division 4, Chapter 30 for determining whether a waste falls into the 'restricted hazardous' or 'hazardous' categories. 'Restricted hazardous wastes' may not be discharged to any waste management unit until they have been treated to reduce their threat to public health and the environment. 'Hazardous wastes' may be discharged only to Class I waste management units which provide both natural geologic and engineered containment features to isolate the wastes from the environment, unless a specific variance has been granted by DHS from the hazardous waste management requirements. 'Nonhazardous solid waste' is another term for municipal solid waste or refuse and is typified by a significant proportion of putrescible (degradable) matter. 'Nonhazardous solid waste', which has stringent moisture-limiting requirements and prohibitions against inclusion of 'designated' or 'hazardous' wastes, may be discharged to Class III landfills that do not provide complete waste containment. 'Inert waste' includes materials which pose only a siltation threat to water quality, such as paving fragments and non-degradable construction debris. Wastes in this category may be discharged to unclassified waste management units that are located and managed to keep the wastes from entering surface waters or drainage channels.

'Designated waste' is defined in §2522(a) of CCR, Title 23, Chapter 3, Subchapter 15 as "1) nonhazardous waste which consists of or contains pollutants which, under ambient environmental conditions at the waste management unit, could be released at concentrations in excess of applicable water quality objectives, or

WASTE AND UNIT CLASSIFICATIONS USED IN CALIFORNIA

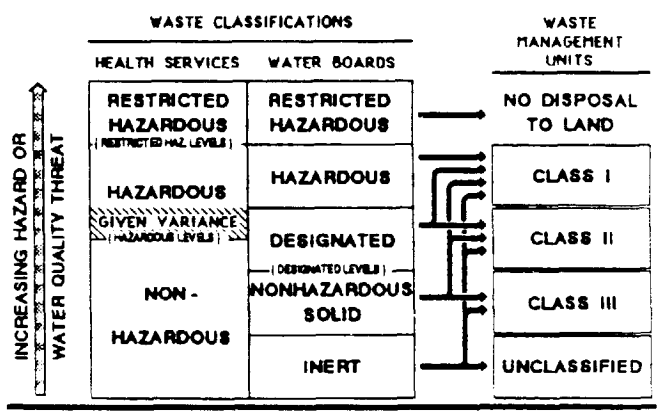

Figure 1

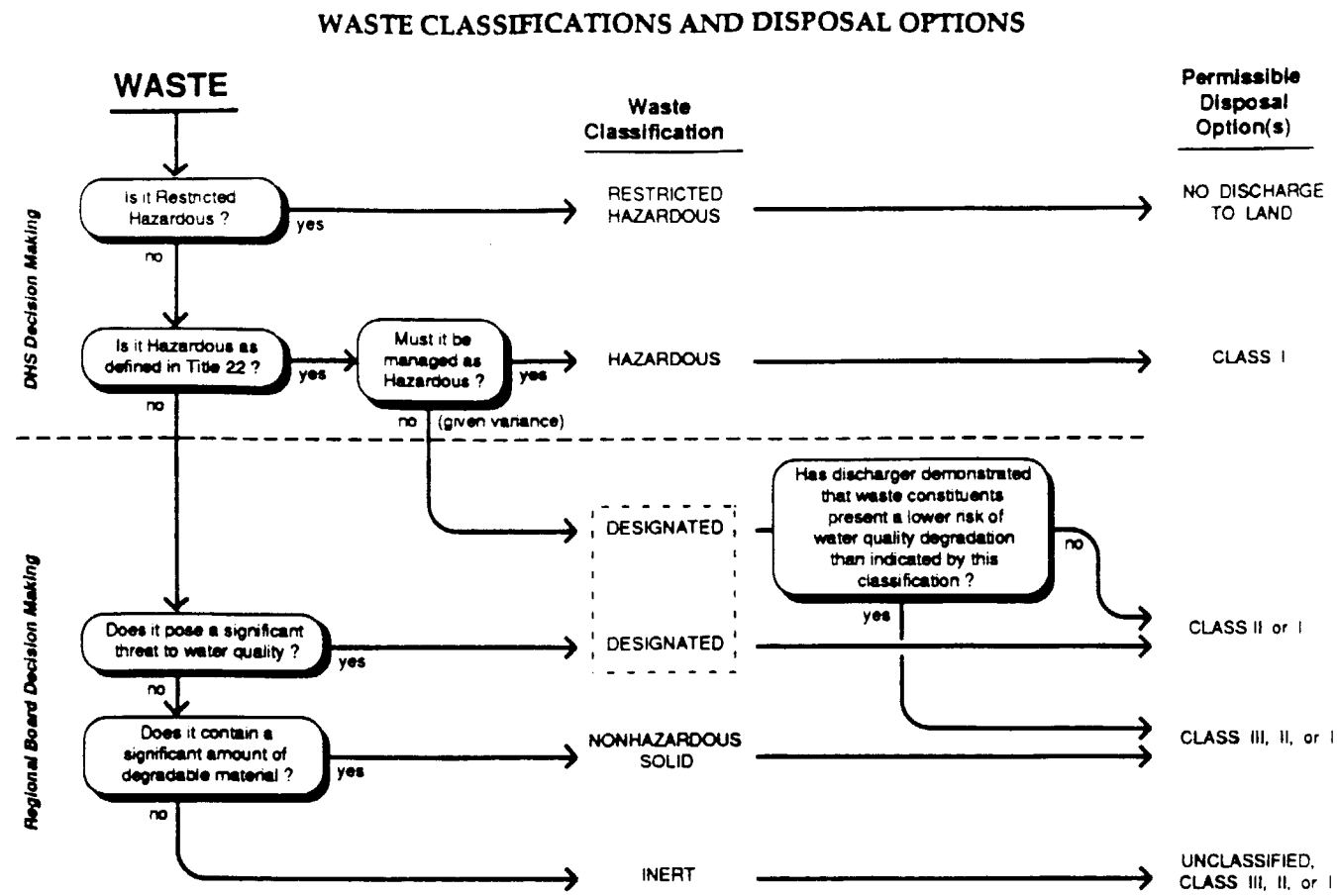

Figure 2

could cause degradation of waters of the State" or "2) hazardous waste which has been granted a variance from hazardous waste management requirements pursuant to Section 66310 of Title 22 of this code." The second part of this definition pertains to those wastes granted a variance by DHS from Class I disposal, as discussed above. The first half of the 'designated waste' definition includes non-hazardous wastes which could impair water quality if discharged to a waste management unit that provides less than Class II containment. 'Designated wastes' are to be discharged to Class II waste management units which have engineered containment features—liners and leachate collection systems—which act to isolate the wastes from ground and surface waters. The Subchapter 15 regulations, however, do not contain guidance on how to apply the first part of the 'designated waste' definition. The purpose of the Designated Level Methodology is to provide this guidance.

It may not be immediately apparent how a non-hazardous waste could pose a threat to water quality. A simple example will illustrate this point. Figure 3 shows an unlined surface impoundment which contains soluble arsenic at a concentration of 4.5 mg/l. The hazardous STLC for arsenic, the level above which a liquid waste becomes hazardous under Title 22 of CCR, is 5 mg/l. Therefore, the waste in this example is not hazardous. The drinking water standard for arsenic is 0.05 mg/l. If natural geologic materials between the base of the impoundment and the water table are unable to sufficiently filter out or attenuate arsenic, the drinking water standard will be exceeded and the ground water will have become unusable for domestic supply. Therefore, this waste at this site would be classified as a 'designated waste', and the impoundment would have to be designed to meet Class II containment standards to isolate the waste from ground water.

THE DESIGNATED LEVEL METHODOLOGY

As shown by the above example, the determination of whether a waste poses a threat to water quality must take into account factors relating to the waste and to the site of proposed discharge. In the Designated Level Methodology, this is accomplished by determining "Designated Levels", concentrations of waste constituents which provide a site-specific indication of the waste's water quality impairment potential. If meas-

THE NEED FOR SITE-SPECIFIC DESIGNATED WASTE CLASSIFICATION

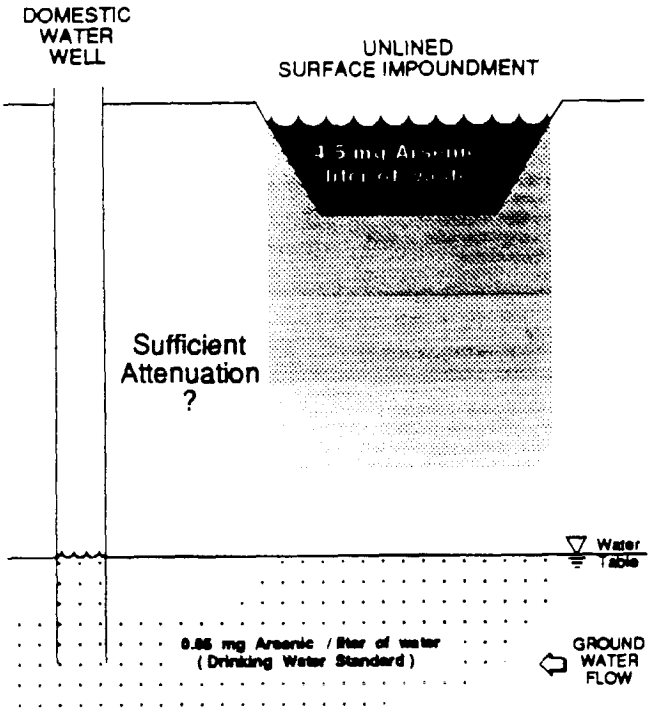

Figure 3

ured concentrations of constituents in a waste exceed these Designated Levels, the waste is assumed to pose a water quality threat at the site in question. Because of the site-specific nature of the determination, the same waste may be classified as 'designated' in one location, but not in another location which provides a greater degree of protection for water quality.

Designated Levels are calculated by first determining the bodies of water which may be affected by the waste management activity in question and the present and probable future beneficial uses of these waters, as shown in Figure 4. Next, site-specific "water quality goals" are selected, based on background water quality or accepted criteria and standards, to protect those beneficial uses. Finally, the most limiting of these water quality goals are multiplied by factors which account for the magnitude of environmental attenuation expected to occur at the proposed site of discharge. The result is a set of Soluble Designated Levels for waste constituents of concern which are specifically applicable to both the waste and site and which, if not exceeded, should protect the beneficial uses of waters of the State. For the site in question, wastes having constituent concentrations in excess of these Designated Levels are assumed to pose a threat to water quality, are classified as 'designated wastes'. As such, these wastes are required to be discharged to waste management units which isolate them from the environment.

Water Quality Goals

Numerical water quality goals, designed to protect the various beneficial uses of ground and surface waters, are selected from a variety of sources. Under a policy established by State Water Resources Control Board Resolution No. 68–16, "Statement of Policy With Respect to Maintaining High Quality of Waters in California", the existing high quality of waters must be maintained unless it can be shown that some degradation in quality is in the best interest of the citizens of California. Therefore, background concentrations of constituents in ground or surface waters that have been unaffected by waste management practices should be used as water quality goals whenever possible. If it has been determined that some degradation in water quality is to be permitted, Resolution No. 68–16 specifies that in no case shall the degradation cause beneficial uses of ground or surface waters to be impaired. Water quality standards and criteria exist in State and Federal regulations and in the literature which provide numerical limits for constituents in waters used for specific purposes. State drinking water

CALCULATING DESIGNATED LEVELS

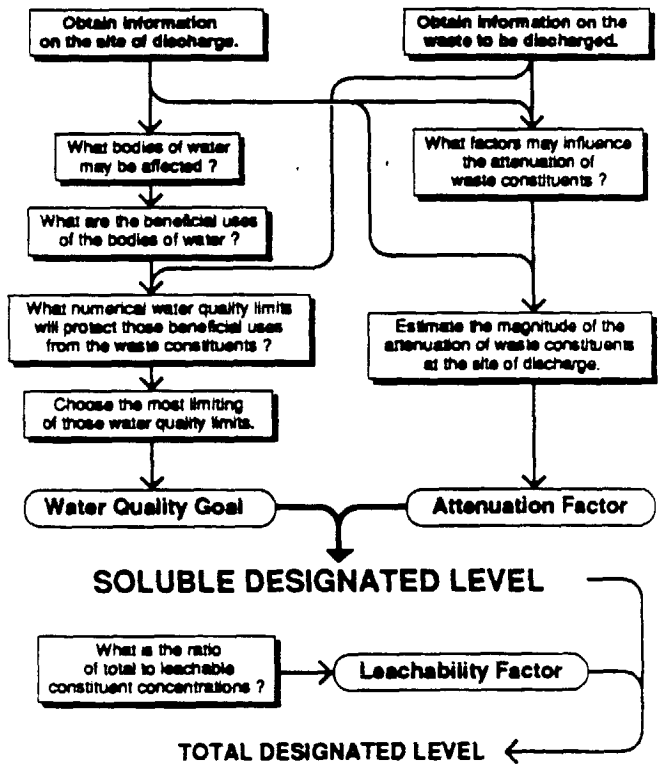

Figure 4

standards, contained in Title 22 of CCR, Division 4, Chapter 15, are designed to protect waters for domestic and municipal supply. The Water Quality Control Plan Reports of the nine Regional Water Quality Control Boards include "water quality objectives" for a variety of uses of specific bodies of water. Under the recently enacted Safe Drinking Water and Toxics Enforcement Act of 1986 (Proposition 65), the Health and Welfare Agency is establishing additional criteria for concentrations of carcinogens and reproductive toxins to protect public health. The Sanitary Engineering Branch of DHS promulgates State "action levels" that are also designed to protect human health from chemical constituents in drinking water. The U.S. Environmental Protection Agency (EPA) and the National Academy of Sciences publish numerous water quality criteria for human health and aquatic life protection. The California Department of Fish and Game can be consulted for aquatic life and wildlife protection criteria. Publications by the State Water Resources Control Board, the Food and Agriculture Organization of the United Nations, the World Health Organization, and others provide additional guidelines. Often several water quality limits can be found for the same chemical. In these cases, the most limiting value that is applicable to the situation in question should be selected as the water quality goal for use in calculating Designated Levels.

Environmental Attenuation Factors

There are a variety of natural processes which act to attenuate (reduce the concentrations of) waste constituents as they migrate through the environment. These processes, which are collectively grouped under the term "environmental fate", include sorption, chemical binding, ion exchange, filtration, diffusion, dispersion, dilution, chemical reaction, biodegradation, and partitioning. By collecting data on the waste constituents and on the site in question, the amount or degree of attenuation which would be expected to occur as the constituents migrate from the location of discharge to either ground or surface water may be estimated. In the Designated Level Methodology, the smallest degree of attenuation that would be expected to occur for the particular constituent at the specific site of discharge is approximated by an "environmental attenuation factor". The greater the amount of attenuation that is expected, the larger the attenuation factor that would be assigned.

As shown in Figure 5, there are a variety of site-specific and constituent-specific characteristics which influence the magnitude of attenuation that may be expected to occur. Also shown are how increases in the environmental characteristics effects the magnitude of the anticipated attenuation and, therefore, the selection of environmental attenuation factors. If ground water is threatened by waste constituents, increases in the depth to ground water (thickness of the vadose zone), in the clay content, organic matter content, ion exchange capacity or pH of vadose zone materials, in the ionic strength, viscosity, degradability or octanol/water partition coefficient (the affinity of the chemical for octanol or soil organic matter versus its affinity for water) of the waste constituent, in the steepness of the terrain, and in the rate of flow of ground water will cause the attenuation factor to be larger (greater attenuation). Increases in the net recharge rate (a driving force for movement of waste constituents), in the permeability or porosity of vadose zone materials, in the polarity or volatility of the waste constituent, in the concentrations of solvents or other chemicals that can increase the permeability of soils or act as carriers for the constituent, or in the mass loading of waste constituents will cause the attenuation factor to be smaller (less attenuation as the constituent migrates to ground water).

EXAMPLES OF ENVIRONMENTAL FATE CHARACTERISTICS WHICH INFLUENCE THE SELECTION OF ATTENUATION FACTORS

As the following characteristics increase...	EFFECT ON ATTENUATION FACTOR: INCREASE	DECREASE
FOR THE PROTECTION OF GROUND WATER —		
• Depth to Highest Ground Water (including capillary fringe)	✓	
• Net Recharge (i.e., [rainfall] — [evaporation])		✓
• Characteristics of the Vadose Zone:		
Permeability and Porosity		✓
Clay Content	✓	
Organic Matter Content	✓	
Ion Exchange Capacity and pH	✓	
• Pollutant Characteristics:		
Polarity		✓
Ionic Strength (more positive)	✓	
Volatility (potential for vapor transport)		✓
Viscosity	✓	
Degradability or Biologic Activity	✓	
Octanol/Water Partition Coefficient (KOW)	✓	
• Other Constituents that Could Increase Mobility		✓
• Topography (steepness of terrain)	✓	
• Total Pollutant Load (mass loading)		✓
• Volumetric Ground Water Flow Rate	✓	
• Uncertainty of the Data and Assumptions		✓
FOR THE PROTECTION OF SURFACE WATERS —		
• Distance from Drainage Courses	✓	
• Topography (steepness of terrain)		✓
• Pollutant Characteristics:		
Volatility (loss to atmosphere)	✓	
Reactivity or Degradability	✓	
Polarity		✓
Octanol/Water Partition Coefficient (KOW)	✓	
• Other Constituents That Could Increase Mobility		✓
• Initial Dilution Upon Reaching Surface Waters (minimum surface water flow vs. maximum pollutant flow)	✓	
• Interconnection of Ground and Surface Waters		✓
• Total Pollutant Load (mass loading)		✓
• Uncertainty of the Data and Assumptions		✓

Figure 5

If surface waters are threatened by constituents in a waste, increases in the distance of travel from the site of waste discharge to surface water, in the volatility, reactivity, degradability or octanol/water partition coefficient of the waste constituent, and in the amount of initial dilution that the waste or leachate would receive upon entering surface waters will cause the attenuation factor to be larger. Increases in the steepness of the terrain, in the polarity of the constituent, in the amount of interconnection of ground and surface waters, in the concentrations of solvents or other chemicals that can act as carriers for the constituent, and in the total constituent loading will lower the attenuation factor.

Undoubtedly the most important characteristic that must be evaluated in the derivation of environmental attenuation factors is the relative uncertainty of the data and assumptions used to quantify environmental fate processes. The more uncertainty involved in the estimation of environmental attenuation factors, the more the assumptions being used in their derivation should lean in the direction of underestimating the amount of attenuation expected to occur. In this way, a greater assurance of water quality protection is provided. The degree of uncertainty in the estimation of environmental attenuation should also be reflected in the amount of vadose zone and ground water monitoring that is required for a waste management unit. Greater uncertainty necessitates a greater monitoring effort to assure that the attenuation factor setting process was sufficiently protective of water quality.

Site- and constituent-specific information regarding key environmental fate characteristics under reasonable worst-case conditions may be used to estimate attenuation factors for specific waste constituents at the site. The DHS publication *The California Site Mitigation Decision Tree Manual*, the EPA document *Water Related Environmental Fate of the 129 Priority Pollutants*, the *Handbook of Environmental Data on Organic Chemicals* by Karel Verschueren, and the EPA publication *DRASTIC: A Standardized System for Evaluating Ground Water Pollution Potential Using Hydrogeologic Settings* contain information and procedures that can be used to assess the fate of chemicals in the environment and estimate environmental attenuation factors for specific waste constituents and site conditions.

Designated Levels for Liquid Wastes

Once the water quality goal is selected and an environmental attenuation factor is estimated, their values are multiplied together to obtain a Designated Level applicable to the specific liquid waste constituent and site of proposed discharge. If the concentration of a constituent in the liquid waste exceeds this level, the waste is classified as a 'designated waste' and Class II containment is required if discharge is to occur to a waste management unit at this site. Wastes having concentrations below the Designated Level are assumed not to pose a significant water quality threat at the site and may be discharged with less than this level of containment.

Soluble Designated Levels for Solid Wastes

As moisture from within a waste or from rainfall percolates toward the base of a landfill, soluble waste constituents are accumulated and leachate is formed. Constituents in leachate at the base of a landfill pose a similar water quality threat to constituents in an impounded liquid waste. The processes of environmental fate which act to attenuate constituent concentrations are the same in either case. Therefore, Designated Levels may be calculated for leachate constituents in the same manner as for liquid waste constituents, as shown in Figure 6. In this example, the drinking water standard for arsenic (0.05 mg/l) has been chosen as the water quality goal to protect ground water at this site for domestic use, and the environmental attenuation factor has been estimated to be equal to "n". The Designated Level for arsenic in

SOLUBLE DESIGNATED LEVEL FOR A CONSTITUENT OF A SOLID WASTE

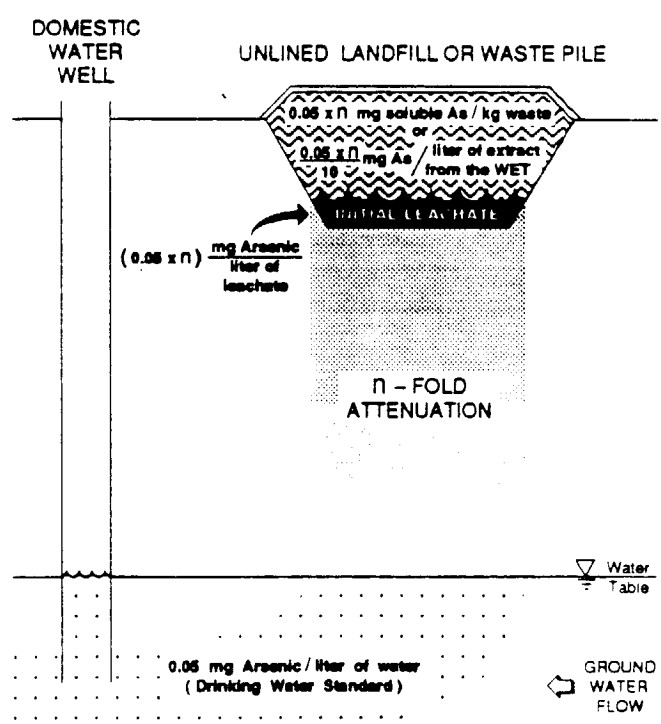

Figure 6

leachate at this site would be equal to (0.05 × n) milligrams arsenic per liter of leachate.

The goal in calculating Designated Levels for a solid waste is to determine concentrations of soluble constituents in the waste above which leachate may be able to carry them to ground or surface waters in amounts that could cause water quality goals to be exceeded. Therefore, the next step in the methodology is to convert the Designated Level for leachate into one which may be applied to concentrations of constituents in a solid waste prior to disposal. Evidence presented by DHS in the Statement of Reasons for the Hazardous Waste Identification Regulations (Title 22 CCR, Division 4, Chapter 30) indicates that the concentrations of constituents in leachate could either be numerically higher or lower than the soluble constituent concentrations in the solid waste prior to leaching. In the calculation of Designated Levels, an assumption is made that these concentrations are numerically equal. Therefore, the Soluble Designated Level for a constituent in a solid waste is numerically the same as the Designated Level for the same constituent in leachate which forms at the base of the landfill—the water quality goal times the environmental attenuation factor. In the example of Figure 6, the Soluble Designated Level for arsenic in the solid waste is (0.05 × n) milligrams of soluble arsenic per kilogram of waste.

SOLUBLE DESIGNATED LEVEL FOR A CONSTITUENT OF CONTAMINATED SOIL

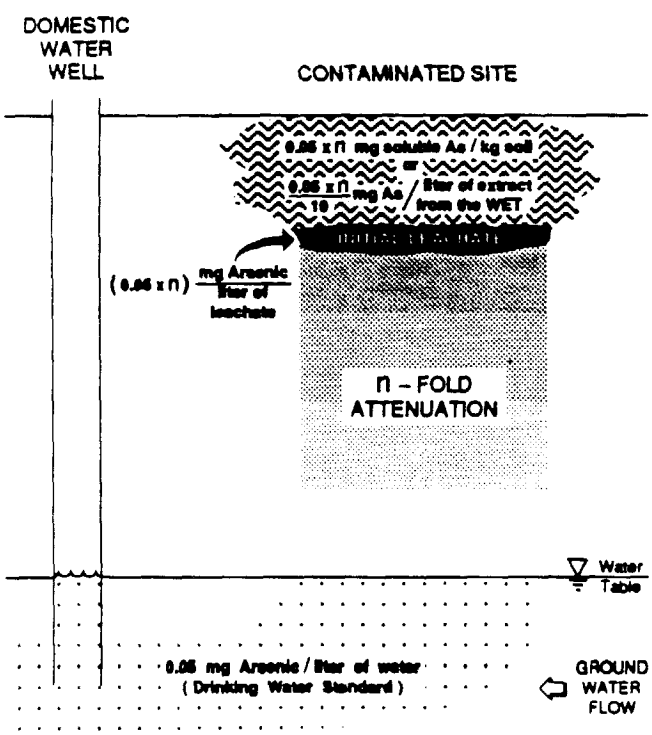

Figure 7

Soluble concentrations of constituents in solid wastes are determined by performing the Waste Extraction Test (WET) from §66700 of Title 22 CCR, or a variation of this test. The test involves a ten-fold dilution of solid waste into an extract solution, agitation for 48 hours, followed by filtration and analysis of the liquid phase. Results are expressed in milligrams of extractable constituent per liter of extract solution. The Soluble Designated Level for a constituent of a solid waste, expressed in the same units, is equal to the water quality goal times the environmental attenuation factor divided by the ten-fold dilution of the WET. For the Figure 6 example, the Soluble Designated Level for arsenic is equal to (0.05 × n ÷ 10) milligrams of arsenic per liter of extract.

Concentrations of constituents in landfill leachate should not be confused with concentrations of constituents in extract from the Waste Extraction Test. They are not the same. Concentrations of constituents in leachate are the result of the accumulation of constituents from the waste as moisture migrates through a landfill or waste pile. Concentrations of constituents in the extract from the WET are the result of a specific laboratory procedure where waste constituents are extracted from a solid waste by an extract solution under a predetermined set of circumstances. The extract from the WET is, therefore, not a simulation of leachate, but a measure of the amounts of waste constituents that may be leached from the waste in a landfill.

CONTAMINATED SITE CLEANUP

DHS has prepared a document entitled *The California Site Mitigation Decision Tree Manual* which presents detailed procedures for determining cleanup/mitigation levels for sites contaminated with toxic substances. The object of these procedures is to prevent toxicologic impacts on humans and other potential "biological receptors of concern". While sufficient to cover DHS's concerns regarding site cleanups, the procedures in this document are not designed to protect all present and probable future beneficial uses of waters of the State that may be adversely impacted by the contaminants, as required by the Porter-Cologne Water Quality Control Act. Therefore, another methodology must be used by the State and Regional Water Boards to fill this need.

Comparison of Figures 6 and 7 shows that the threat posed to water quality by contaminated soils is similar to that posed by wastes in an unlined landfill. There-

fore, the Designated Level Methodology can be used to select cleanup levels which will protect the quality of nearby ground and surface waters. As always, background concentrations of contaminants must be factored into the cleanup level-setting process. Background water quality data in conjunction with water quality standards and criteria are used to select water quality goals which protect the beneficial uses of ground and surface waters which could be adversely impacted by contaminants. Attenuation factors are estimated based upon site hydrogeologic data and information on the contaminants themselves. Soluble Designated Levels are then calculated by multiplying the water quality goals by the attenuation factors and dividing by the ten-fold dilution of the WET. The results are expressed as milligrams of soluble constituent per liter of extract.

Soil samples are subjected to the WET procedure and results are compared with these site- and constituent-specific Soluble Designated Levels. Cleanup and/or mitigation would be required for soils having extractable concentrations which exceed Soluble Designated Levels. For site cleanup situations the WET procedure is often modified to account for conditions that exist at the site. The WET uses an acidic buffered extraction solution which is designed to account for the acidic conditions often encountered in sanitary landfills. If the site being investigated presents neutral or basic conditions, deionized water or another more suitable extraction solution may be substituted for the standard WET buffer solution (assuming the contaminated soils themselves cannot generate acid).

CONCLUSION AND STATUS

When combined with the waste classification and cleanup level setting processes of DHS and the State Water Board's Subchapter 15 regulations, the Designated Level Methodology can provide a complimentary set of procedures to ensure the protection of both the public health and the quality of usable waters of California. Comments received during public review of an earlier draft of the Designated Level Methodology report were used to produce the October 1986 version. Staff of the Central Valley Regional Water Quality Control Board submitted this version of the report to the State Water Resources Control Board and is currently working with staff of that agency to develop statewide policy in this area. In June 1989, an updated version of the Methodology was produced to keep the document current with changes in water quality criteria and waste testing methods.

THE DESIGNATED LEVEL METHODOLOGY FOR WASTE CLASSIFICATION AND CLEANUP LEVEL DETERMINATION

EXECUTIVE SUMMARY

Improper waste disposal practices and sites which have been contaminated with toxic substances pose significant threats to the quality of California's useable ground and surface water resources. This report shows, from a water quality perspective, 1) how to classify various wastes so that appropriate disposal practices may be selected, and 2) how to determine the degree to which a contaminated site should be cleaned or to which remedial action is necessary ("how clean is clean"), and 3) how these two decision-making processes are related.

In California, the classification of wastes and the establishment of cleanup levels for sites which have been contaminated with toxic chemicals are performed by two separate State agencies with separate regulatory authority. The Department of Health Services (DHS) classifies wastes as 'hazardous' or 'restricted hazardous' and sets site cleanup/mitigation criteria based on a direct threat of these wastes or sites to public health. The State Water Resources Control Board together with the nine Regional Water Quality Control Boards classify wastes as 'designated', 'nonhazardous solid' or 'inert' and determine cleanup levels based on the threat that wastes and contaminated sites pose to the beneficial uses of waters of the State, as required by the Porter-Cologne Water Quality Control Act (contained in Division 7 of the California Water Code).

Regulations administered by these agencies clearly state, using detailed criteria, how wastes are to be classified with the exception of the 'designated waste' category. The lower boundary of this category is described only as the limit above which a waste could impair water quality at the site of discharge. This boundary can be more clearly defined by establishing "Designated Levels" for specific constituents of a waste which provide a site-specific indication of the water quality impairment potential of the waste. This report provides a methodology for calculating such levels. Designated Levels are calculated by first determining the bodies of water that may be affected by a waste and the present and probable future beneficial uses of these waters. Next, site-specific "water quality goals" are selected, based on background water quality or accepted criteria and standards, to protect those beneficial uses. Finally, these water quality goals are multiplied by factors which account for environmental attenuation and leachability. The result is a set of Soluble and Total Designated Levels which are applicable to a particular waste and disposal site and which, if not exceeded, should protect the beneficial uses of waters of the State. Wastes having constituent concentrations in excess of these Designated Levels are assumed to pose a threat to water quality and are, therefore, classified as 'designated wastes' and directed to waste management units which isolate these wastes from the environment.

In 1986, DHS released a document entitled The California Site Mitigation Decision Tree Manual[25] which presents a detailed methodology for determining cleanup/mitigation levels for sites contaminated with toxic substances. The object of this methodology is to

prevent toxicologic impacts on humans and other potential "biological receptors of concern". While sufficient to cover DHS's interests in site cleanups, this methodology is not designed to protect all present and probable future beneficial uses of waters that may be adversely impacted by the contaminants. It can be shown that the threat posed to water quality by contaminated soils is closely related to that posed by wastes in an unlined landfill. As such, the Designated Level Methodology can be used to select cleanup levels which will protect the quality of nearby ground and surface waters. As always, the background concentrations of contaminants must be factored into the cleanup level setting process.

When combined with the waste classification and cleanup level setting processes of DHS and the State Water Board's Subchapter 15 regulations, the Designated Level Methodology can provide a complimentary set of procedures to ensure the protection of both the public health and the quality of useable waters of California.

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Chapter 1 PURPOSE

This report is intended to provide information and suggested procedures to be used in addressing the complex issues of waste classification and cleanup level determination from a purely water quality-based point of view. Currently available procedures of State and Federal regulatory agencies are insufficient to protect all present and probable future beneficial uses of waters of California from waste disposal and contaminated site cleanup/ mitigation activities, as required by the Porter-Cologne Water Quality Control Act and policies and regulations of the State Water Resources Control Board. The procedures presented herein are not intended to supersede the authority or procedures of other regulatory agencies in these areas, but should complement them in a manner consistent with beneficial use protection. The Department of Health Services, the Department of Fish & Game, and the Air Resources Board should also be consulted with respect to human health, fish and wildlife, and air quality impacts of waste disposal and site cleanup activities. Appropriate local agencies should also be contacted for concurrence with decisions made in these areas.

Our knowledge of the environmental fate and impact of chemicals on the quality of our water resources is constantly evolving. The methodology presented in this report for defining the lower boundary of the 'designated waste' classification and 'how-clean-is-clean', from a water quality perspective, reflects our current level of understanding of these complex subjects and contains sufficient flexibility to permit modifications as our knowledge increases. The Designated Level Methodology will periodically be refined and updated to account for the evolution of our understanding of environmental fate processes and the effects of chemicals on water quality.

Chapter 2 WASTE CLASSIFICATION

Two State agencies share responsibility for the classification of wastes in California: 1) the Department of Health Services and 2) the State Water Resources Control Board together with the nine Regional Water Quality Control Boards. These agencies classify wastes according to regulations contained in Title 22 of the California Code of Regulations (CCR), Division 4, Chapter 30, "Minimum Standards for Management of Hazardous and Extremely Hazardous Wastes" [1] and Title 23, CCR, Chapter 3, Subchapter 15, "Discharges of Waste to Land",[2] respectively. Classifications used by DHS reflect that agency's mandate to protect public health, while classifications used by the Water Boards are designed to implement their mandate to protect present and probable future beneficial uses of water. Based on these two classification schemes, the State determines proper methods for disposal for each type of waste generated in California. Figure 1 summarizes the two waste classification schemes and the resulting selections of appropriate waste management units for the classified wastes.

Under the waste management regulations contained in Titles 22 and 23, DHS determines whether a waste is 'restricted hazardous' or 'hazardous', while classification of a waste as 'designated', 'nonhazardous solid', or 'inert' is performed by the Water Boards. The relationships between regulatory decisions, waste classifications, and disposal options are shown in Figure 2.

Figure 1

WASTE AND UNIT CLASSIFICATIONS USED IN CALIFORNIA

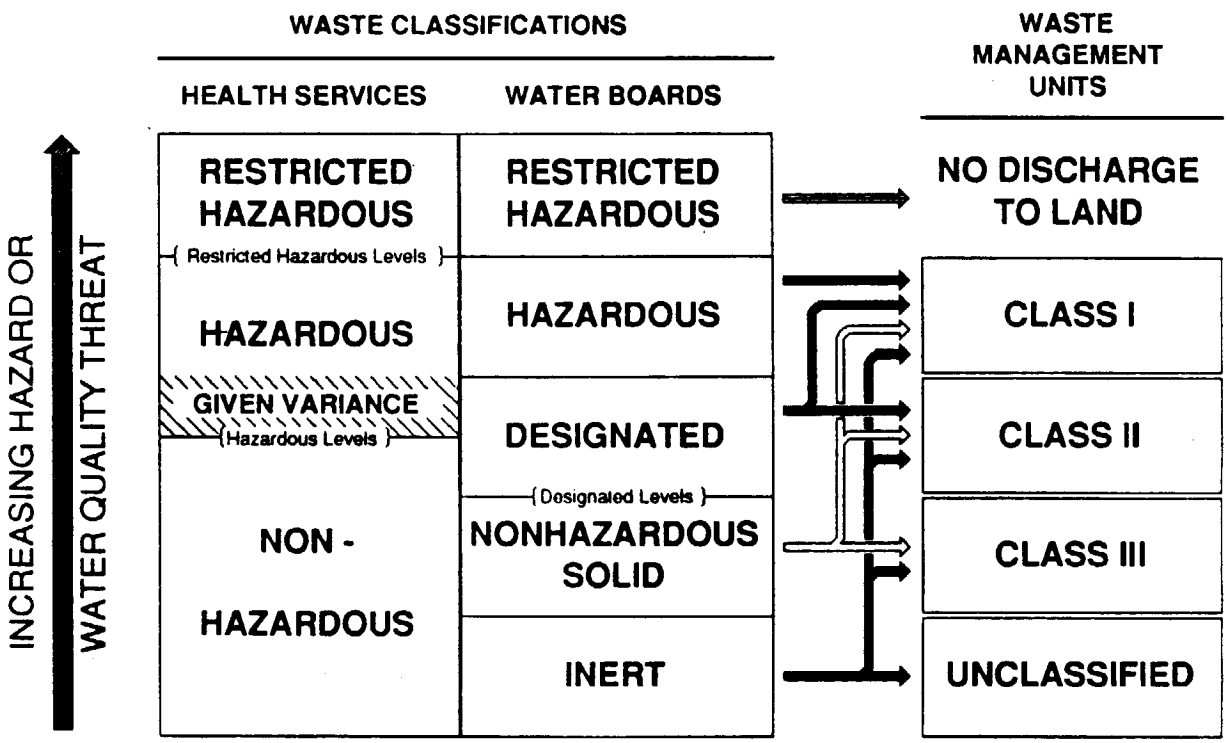


Figure 2

WASTE CLASSIFICATIONS AND DISPOSAL OPTIONS UNDER TITLE 23, CCR, CHAPTER 3, SUBCHAPTER 15

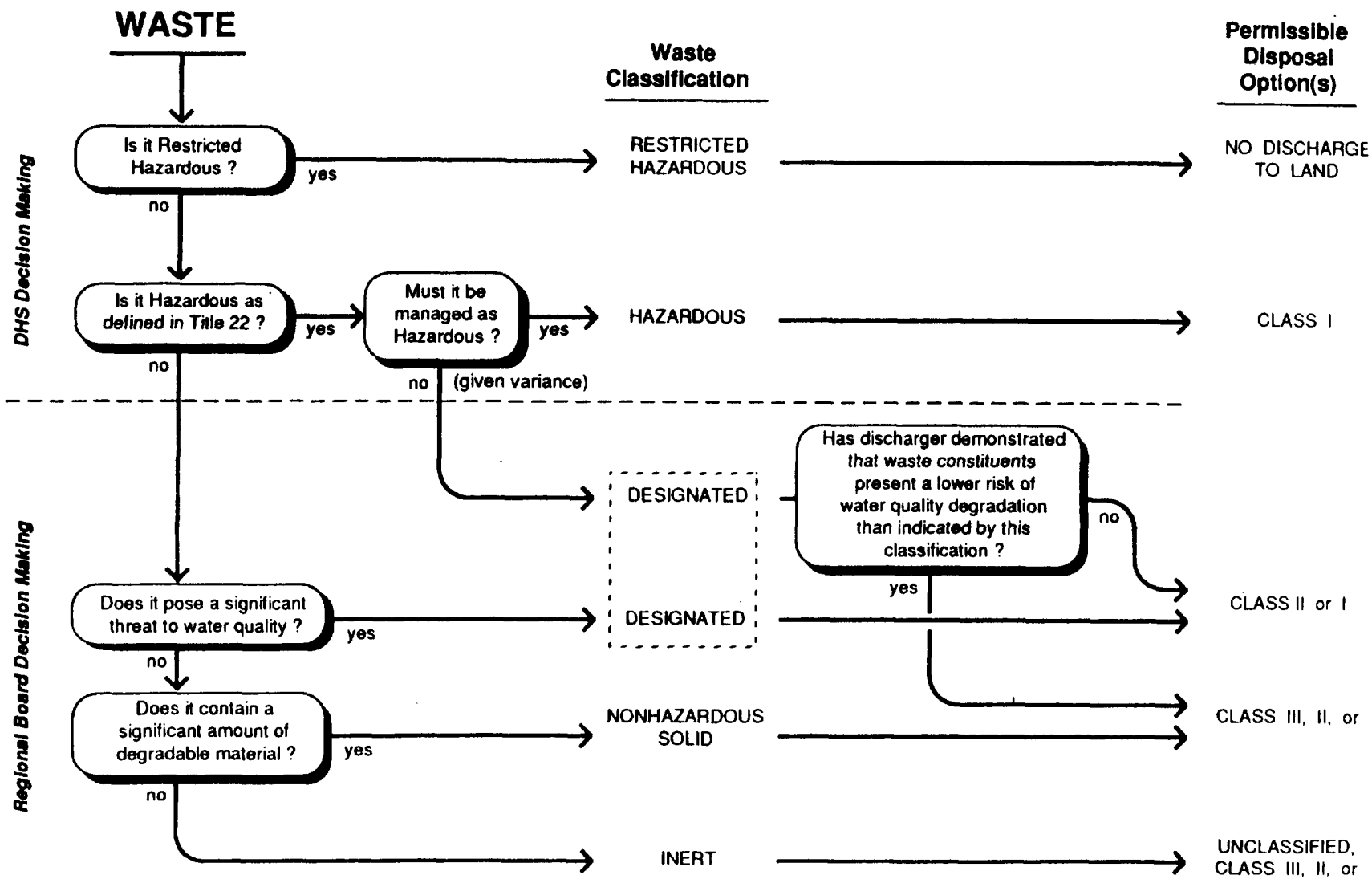


Figure 3

CALIFORNIA LAND DISPOSAL RESTRICTIONS

RESTRICTED HAZARDOUS WASTES		RESTRICTION DATE
• **Liquids** containing **Free Cyanides** ≥ **1000 mg/l**		1 June 1983
• **Liquids** containing **Dissolved Metals** ≥ **the following limits :**		1 January 1984
Arsenic	**500 mg/l**	
Cadmium	**100 mg/l**	
Chromium (VI)	**500 mg/l**	
Lead	**500 mg/l**	
Mercury	**20 mg/l**	
Nickel	**134 mg/l**	
Selenium	**100 mg/l**	
Thallium	**130 mg/l**	
• **Liquids** having a **pH ≤ 2.0** (acidic)		1 January 1984
• **Liquids** containing **PCBs ≥ 50 mg/l**		1 January 1984
• The following wastes containing **Halogenated Organics** ≥ **1000 mg/kg** (total) **:**		
Liquids		1 January 1985
Organic Sludges and Solids		8 July 1989

2.1 'Restricted Hazardous Wastes'

Wastes which pose the greatest threat to human health and the environment fall into the category of 'restricted hazardous wastes' and may not be discharged to any landfill, waste pile, surface impoundment, or land treatment unit after the restriction dates shown in Figure 3.[1] Article 15 of the hazardous waste management regulations, beginning with §66900 of Title 22, CCR, defines these wastes by listing specific chemical concentrations (Restricted Hazardous Levels) above which a waste is 'restricted hazardous' (see Figures 1 and 3). Any 'restricted hazardous waste' must be treated to below Restricted Hazardous Levels prior to discharge to a waste management unit.

2.2 'Hazardous Wastes'

A waste may be classified as 'hazardous' by any of several means. Article 9, §66680(d) and (e), of the hazardous waste management regulations[1] provides lists of wastes and waste constituents (List of Common Names and List of Chemical Names). Any waste listed in the List of Common Names or any waste containing constituents listed in the List of Chemical Names is presumed to be a 'hazardous waste' unless shown to be otherwise by means of criteria contained in Article 11. ['Restricted hazardous wastes' and 'extremely hazardous wastes' are subsets of 'hazardous wastes' under these regulations. 'Extremely hazardous wastes' are not discussed further in this report.]

Article 11 of the hazardous waste management regulations, beginning with §66693, establishes criteria in four areas — toxicity, ignitability, reactivity, and corrosivity. A waste meeting any of these criteria is considered to be 'hazardous' by DHS. The toxicity criteria, summarized in Figure 4, include acute oral, dermal, inhalation and fish toxicity, carcinogenicity, and compound specific toxicity. The carcinogenicity criteria include a list of compounds for which the combined concentration in a waste exceeding 0.001 percent by weight (10 mg/kg or 10 ppm) makes the waste 'hazardous'. These compounds are:

2-Acetylaminofluorene (2-AAF)	4-Dimethylaminoazobenzene (DAB)
Acrylonitrile	Ethyleneimine (EL)
4-Aminodiphenyl	a-Naphthylamine (1-NA)
Benzidine and its salts	b-Naphthylamine (2-NA)
bis (Chloromethyl) ether (BCME)	4-Nitrobiphenyl (4-NBP)
Methyl chloromethyl ether	N-Nitrosodimethylamine (DMN)
1,2-Dibromo-3-chloropropane (DBCP)	b-Propiolactone (BPL)
3,3'-Dichlorobenzidine and its salts (DCB)	Vinyl Chloride (VCM)

The regulations include other carcinogenicity criteria in addition to this list of compounds.

The compound-specific toxicity criteria include concentration limits for several "persistent and bioaccumulative" toxic substances. The limits are called Soluble Threshold Limit Concentrations (STLCs) and Total Threshold Limit Concentrations (TTLCs) shown in Figures 5 and 6. A **solid** waste is 'hazardous' if any of the **extractable** concentrations of its toxic constituents (in mg/l of extract) equals or exceeds the STLC and/or any of the **total** concentrations of its toxic constituents (in mg/kg of waste) equals or exceeds the TTLC. The Waste Extraction Test (WET) is used to determine extractable concentrations of toxic constituents in a waste, expressed in milligrams per liter (mg/l) of extract. The full WET procedure (§66700 of Title 22, CCR) may be found in Appendix I to this report. A **liquid** waste is hazardous if any of the **total** concentrations of its toxic constituents (in mg/l of waste) exceeds the STLC. All concentrations are expressed on a wet-weight basis (as the waste is to be discharged).

Once a waste is classified as 'hazardous' under the Title 22 regulations, it must be managed as a 'hazardous waste' — discharged only to a Class I waste management unit — unless the waste generator or handler is able to demonstrate to DHS that Class I containment is not necessary to protect public health from the particular waste. The Alternative Technology

Figure 4

HAZARDOUS WASTE TOXICITY CRITERIA

ACUTE ORAL TOXICITY CRITERION:
acute oral LD50 < 5,000 mg/kg body weight

ACUTE DERMAL TOXICITY CRITERION:
acute dermal LD50 < 4,300 mg/kg body weight

ACUTE INHALATION TOXICITY CRITERION:
acute inhalation LD50 < 10,000 ppm in air

ACUTE FISH TOXICITY TEST:
aquatic 96-hour LC50 < 500 mg/l of water

CARCINOGENICITY:
sum of listed carcinogens > 10 ppm

COMPOUND SPECIFIC TOXICITY:
extractable concentrations >
Soluble Threshold Limit Concentrations (STLCs)
and/or
total concentrations >
Total Threshold Limit Concentrations (TTLCs)

Section of DHS (916/322-2822 or ATSS 492-2822) determines whether variances may be granted for these wastes. If not granted such a variance, the waste is also classified as a 'hazardous waste' under the Water Boards' Subchapter 15 regulations[2] which permit discharge only to a Class I waste management unit (see Figures 1 and 2). Such units are required by the regulations to isolate the waste from the surrounding environment through both natural and engineered controls.

If DHS grants a Title 22 'hazardous waste' a variance from being managed as 'hazardous', Subchapter 15 defines that waste as a 'designated waste'. Thus, the same waste may be classified as 'hazardous' under Title 22 and as 'designated' under Title 23.

Figure 5

DEPARTMENT OF HEALTH SERVICES CRITERIA FOR INORGANIC CONSTITUENTS OF HAZARDOUS WASTES

SUBSTANCE	THRESHOLD LIMIT CONCENTRATION SOLUBLE (STLC) mg/l in extract	TOTAL (TTLC) wet wt. mg/kg
Antimony and/or Antimony Compounds	15	500
Arsenic and/or Arsenic Compounds	5.0	500
Asbestos	—	1.0%
Barium and/or Ba Compounds (excl. Barite)	100	10,000
Beryllium and/or Beryllium Compounds	0.75	75
Cadmium and/or Cadmium Compounds	1.0	100
Chromium (VI) Compounds	5	500
Chromium and/or Chromium (III) Compounds	560	2,500
Cobalt and/or Cobalt Compounds	80	8,000
Copper and/or Copper Compounds	25	2,500
Fluoride Salts	180	18,000
Lead and/or Lead Compounds (inorganic)	5.0	1,000
Mercury and/or Mercury Compounds	0.2	20
Molybdenum and or Molybdenum Compounds	350	3,500
Nickel and/or Nickel Compounds	20	2,000
Selenium and/or Selenium Compounds	1.0	100
Silver and/or Silver Compounds	5	500
Thallium and/or Thallium Compounds	7.0	700
Vanadium and/or Vanadium Compounds	24	2,400
Zinc and/or Zinc Compounds	250	5,000

2.3 'Designated Wastes'

As defined in §2522 of the Subchapter 15 regulations, 'designated waste' is either of the following:

"1) nonhazardous waste which consists of or contains pollutants which, under ambient environmental conditions at the waste management unit, could be released at concentrations in excess of applicable water quality objectives, or could cause degradation of waters of the state.

Figure 6

DEPARTMENT OF HEALTH SERVICES CRITERIA FOR ORGANIC CONSTITUENTS OF HAZARDOUS WASTES

SUBSTANCE	THRESHOLD LIMIT CONCENTRATION SOLUBLE (STLC) mg/l in extract	TOTAL (TTLC) wet wt. mg/kg
Aldrin	0.14	1.4
Chlordane	0.25	2.5
DDT, DDE, DDD	0.1	1.0
2,4-Dichlorophenoxyacetic Acid (2,4-D)	10	100
Dieldrin	0.8	8.0
Dioxin (2,3,7,8-TCDD)	0.001	0.01
Endrin	0.02	0.2
Heptachlor	0.47	4.7
Kepone	2.1	21
Lead Compounds, Organic	—	13
Lindane	0.4	4.0
Methoxychlor	10	100
Mirex	2.1	21
Pentachlorophenol	1.7	17
Polychlorinated Biphenyls (PCBs)	5.0	50
Toxaphene	0.5	5
Trichloroethylene (TCE)	204	2,040
2,4,5-Trichlorophenoxypropionic Acid	1.0	10

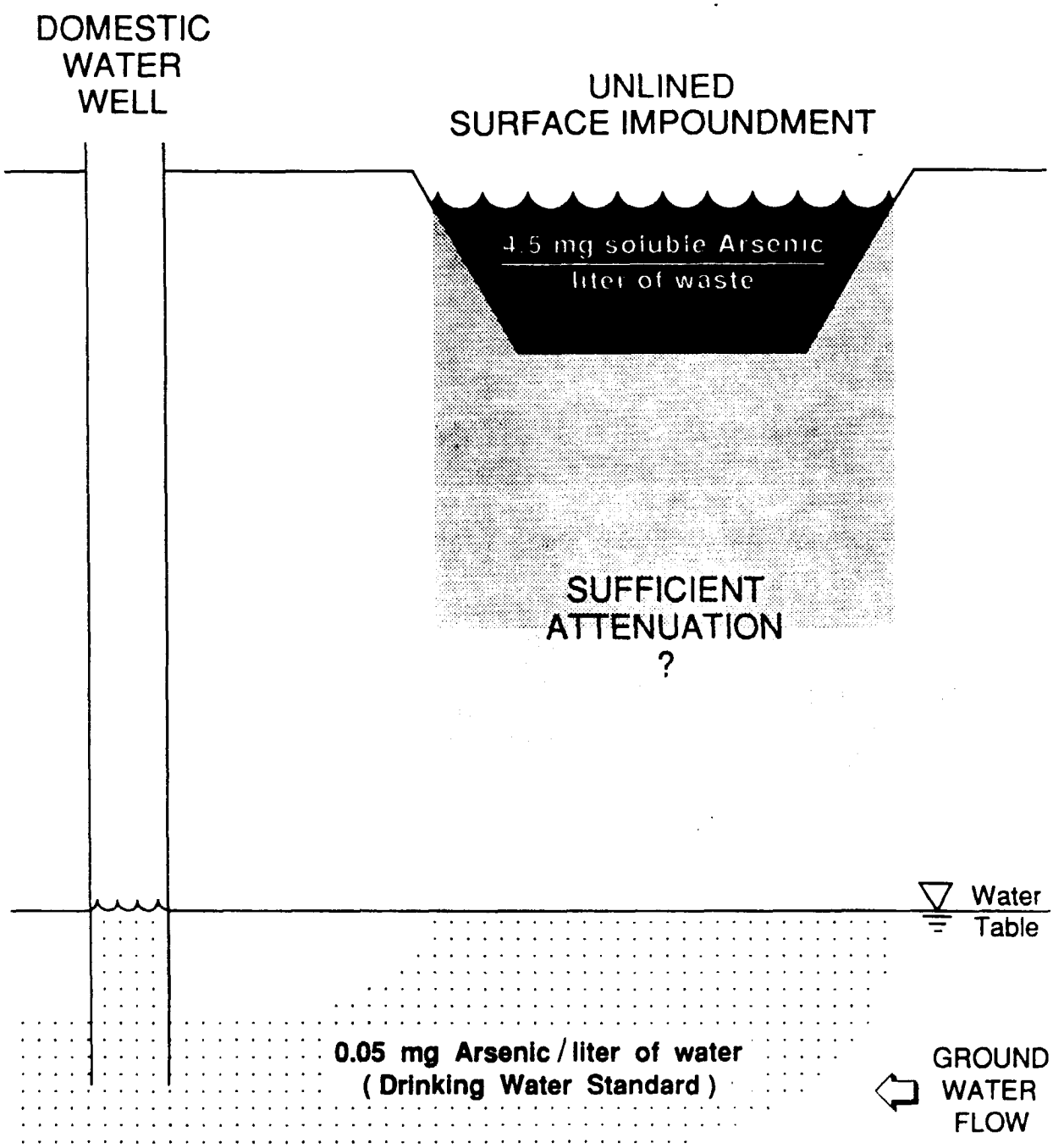
"2) hazardous waste which has been granted a variance from hazardous waste management requirements pursuant to Section 66310 of Title 22 of this code."

The granting of variances for hazardous wastes was discussed in Section 1.2 above. However, a waste also becomes 'designated' is if it is not 'hazardous' but still poses a threat to water quality at the site of disposal. An example will clarify this point.

Figure 7 shows a situation in which a liquid waste containing 4.5 mg/l of arsenic is discharged to an unlined surface impoundment over ground water that may be used for domestic supply. The hazardous STLC for arsenic is 5 mg/l, so the waste is not 'hazardous' under Title 22. The drinking water standard for arsenic is 0.05 mg/l. Ground water above that level could cause adverse health effects if consumed over a prolonged

Figure 7

THE NEED FOR SITE-SPECIFIC 'DESIGNATED WASTE' CLASSIFICATION



period of time. As the liquid waste percolates through the soil, its arsenic concentration will be reduced by various attenuative mechanisms, such as adsorption and precipitation. If these mechanisms are not capable of reducing the arsenic concentration sufficiently (high permeability soils and/or insufficient separation between the waste and ground water), enough arsenic will enter ground water to cause the drinking water standard to be exceeded. Its beneficial use for domestic supply would be impaired. In this situation the waste would be classified as a 'designated waste'.

It can be seen from the example above that: 1) the classification of a waste as 'hazardous' is made purely on waste-specific factors, while the classification of a waste as 'designated' must be based on both waste- and site-specific factors; and 2) the 'hazardous waste' classification system is insufficient to protect all waters of the State from the discharge of wastes to land. Subchapter 15 provides no guidance to the Regional Boards on how to determine whether a non-'hazardous' waste should be classified as 'designated' other than the language in §2522, quoted above. A methodology for making these decisions is provided in Chapter 3 of this report.

Subchapter 15 requires 'designated wastes' to be discharged to Class I or Class II waste management units. These units are to be designed to isolate the wastes from the surrounding environment through natural and/or engineered controls. Under §2520(a)(1) of Subchapter 15, a Title 22 'hazardous waste' that is given a variance by DHS may be discharged to a Class III waste management unit if the discharger demonstrates to the appropriate Regional Board that the waste does not pose a significant threat to water quality (see Figure 2). Only rarely will the discharger be able to make this demonstration. An example of a waste for which this demonstration is appropriate is asbestos. Wastes containing over 1.0 % asbestos are 'hazardous' under Title 22; however, DHS has granted asbestos a variance from hazardous waste management if these wastes are double-bagged and covered immediately after discharge. If discharged to a Class III landfill, the asbestos does not pose a threat to ground water quality, since asbestos fibers are unable to migrate through soils. The Regional Boards, therefore, frequently grant a §2520(a)(1) variance from Class II disposal for these 'designated wastes'.

2.4 'Nonhazardous Solid Wastes' and 'Inert' Wastes

Wastes in the remaining two classifications of Subchapter 15 are not required to be discharged to waste management units which provide isolation from the surrounding environment. 'Nonhazardous solid waste' is more commonly referred to as "municipal solid waste" or "refuse". It contains a significant quantity of degradable materials, but cannot contain 'designated waste'. Examples of 'nonhazardous solid waste' include solid refuse from food processing and handling, paper products, cardboard, wood, rubber, tree prunings, and dead animals. Subchapter 15 allows 'nonhazardous solid waste' to be discharged to Class III waste management units which are located and/or designed to prevent impairment of beneficial uses of nearby ground and surface waters. Thus, limited or controlled leakage of leachate from the waste to the surrounding environment is permitted.

'Inert waste' does not contain 'designated waste' nor a significant amount of degradable material. The only water quality threat posed by these wastes is siltation. Examples of 'inert waste' include construction and demolition wastes such as clean earth, rock, concrete and inert plastics, vehicle tires, uncontaminated clay products, and glass. 'Inert wastes' may be discharged to unclassified waste management units as long as they are prevented from entering surface waters. [Unclassified waste management units may have Waste Discharge Requirements from the appropriate Regional Board.] Again the emphasis is on beneficial use protection, rather than isolation of the waste from the surrounding environment.

Chapter 3 THE DESIGNATED LEVEL METHODOLOGY

Existing California regulations clearly define how wastes are to be classified; and detailed guidance is provided for the implementing agencies to set all but one of the boundaries between the five major waste classes (see Figure 1). The one significant boundary not clearly delineated is the lower end of the 'designated waste' classification. Wastes above this boundary — 'designated wastes' and 'hazardous wastes' — have the potential to significantly degrade water quality and must be discharged to waste management units (Class II and Class I) which isolate them from the surrounding environment (see Figure 2). Wastes below this boundary — 'nonhazardous solid wastes' and 'inert wastes' — may be discharged to units (Class III and unclassified) that do not provide this isolation. Thus, failure to classify a waste as 'designated' or 'hazardous' permits its discharge to waste management units that have little or no natural or engineered controls to prevent the release of waste constituents to the environment (most Class III and unclassified units are not required to have liners nor leachate collection and removal systems).

How are the regulatory agencies and the regulated community to determine whether a waste discharged to one of these waste management units poses a threat to beneficial uses of water? The following discussion presents a methodology which may be used to determine whether a waste has the potential to degrade water quality if discharged to a waste management unit that provides less than Class II containment. The methodology defines the lower boundary of the 'designated waste' classification (as well as the criteria which may be used to grant §2520(a)(1) variances under Subchapter 15) by establishing "Designated Levels" (see Figure 1). These levels are concentrations of waste constituents above which a waste is presumed to pose a threat to water quality at the site being considered. Designated Levels are derived from numerical "water quality goals", limits or levels of water quality constituents which are established to protect the beneficial uses of water. Wastes whose constituent concentrations exceed the site-specific Designated Levels should be classified as 'designated wastes' with respect to that site, and the site should be required to provide Class II containment under Subchapter 15.

[The Designated Level Methodology is adapted from a procedure used by DHS to calculate 'hazardous' STLCs and TTLCs from drinking water standards, which is presented in the document "Final Statement of Reasons for Proposed Regulations, 'Criteria for Identification of Hazardous and Extremely Hazardous Wastes'" in Title 22 (CAM SOR), adopted by DHS in February 1984.[3]]

3.1 Determining Available Concentrations of Waste Constituents

In order to determine the threat posed to water quality by a particular waste it is first necessary to ascertain the quantity of each constituent of concern in the waste that is available to migrate to waters of the State.

3.1.1 Liquid Wastes

The quantity of chemical constituents that is available to migrate from liquid wastes is dependent on the expected migration route. Only the **dissolved** concentrations of waste

constituents are available to migrate through soils to ground or surface waters. In cases where a waste may only threaten ground water, filtered samples should be subjected to analysis.

Note: Caution should be exercised in the decision to filter samples for analysis. Increased exposure of a sample to air that may occur during the filtration process can increase the dissolution of carbon dioxide and result in changes of chemical equilibria that, in turn, can alter the solubilities of many constituents. Erroneous analytical data may be the final result.

If overland flow to surface waters is possible, the **total** constituent concentrations may be available for movement and analyses should be conducted on unfiltered samples.

3.1.2 Solid Wastes

Since it is the soluble fraction of a constituent of a solid waste which actually has the potential to migrate to waters of the State, the **extractable** concentration is a more accurate measure (than the total concentration) of the ability of a particular solid waste constituent to degrade water quality. Therefore, it is recommended that whenever possible, extractable concentrations be determined for use in classifying solid wastes for purposes of water quality protection.

Determining Extractable Concentrations

For consistency with the hazardous waste identification procedures in Title 22 of CCR, extractable waste constituent concentrations should be determined using the Waste Extraction Test (WET) procedure from §66700 of those regulations, as indicated in Figures 8 and 9. The full WET procedure is contained in Appendix I to this report. In many cases, waste generators or dischargers must perform this test on their wastes to comply with the hazardous waste identification regulations of Title 22 of CCR, Division 4, Chapter 30, Article 11. Thus, much of the data needed to determine whether the waste is a 'designated waste' will be generated by that process. Further justification for use of the WET over other extraction procedures is presented in the CAM SOR.[3]

Note: Users are cautioned to ignore the phrase in part (b) of the WET procedure which permits the elimination of analyses for constituents whose total concentrations in the waste fall below hazardous STLC criteria (see Appendix I below). This exemption was developed for determinations of whether a waste is 'hazardous' under Title 22 of CCR. The determination of whether a waste is 'designated' under Subchapter 15 often involves more stringent criteria and these eliminated analytical results may be critical to this determination.

As shown in Figure 9, the WET requires a 10-fold dilution (wt./vol.) of waste into the extract solution. The results of the extraction in terms of milligrams of soluble constituent **per liter of extract solution** (mg/l) is, therefore, equal to one tenth (1/10) of the concentration expressed in milligrams of soluble constituent **per kilogram of solid waste**. This fact will be used in the calculation of Designated Levels in Section 3.3.3 of this report.

Figure 8

DETERMINING SOLUBLE/EXTRACTABLE CONCENTRATIONS OF CONSTITUENTS OF WASTES OR SOILS

Extraction Procedure

Waste Extraction Test (WET) from Title 22, CCR, §66700 with the following modifications :

Selecting the Extractant

Especially important for metallic constituents.

1) **Are the wastes/soils in a potentially acidic environment ?**

2) **Are the wastes/soils capable of generating acid ?**

Determine Acid-Base Account

If *either* answer is "yes" . . .
extract with the standard Citrate Buffer.

If *both* answers are "no" . . .
extract with Deionized Water.
May need to adjust to the acidity of local rainfall.

Select Extraction Vessel

For volatile constituents . . .

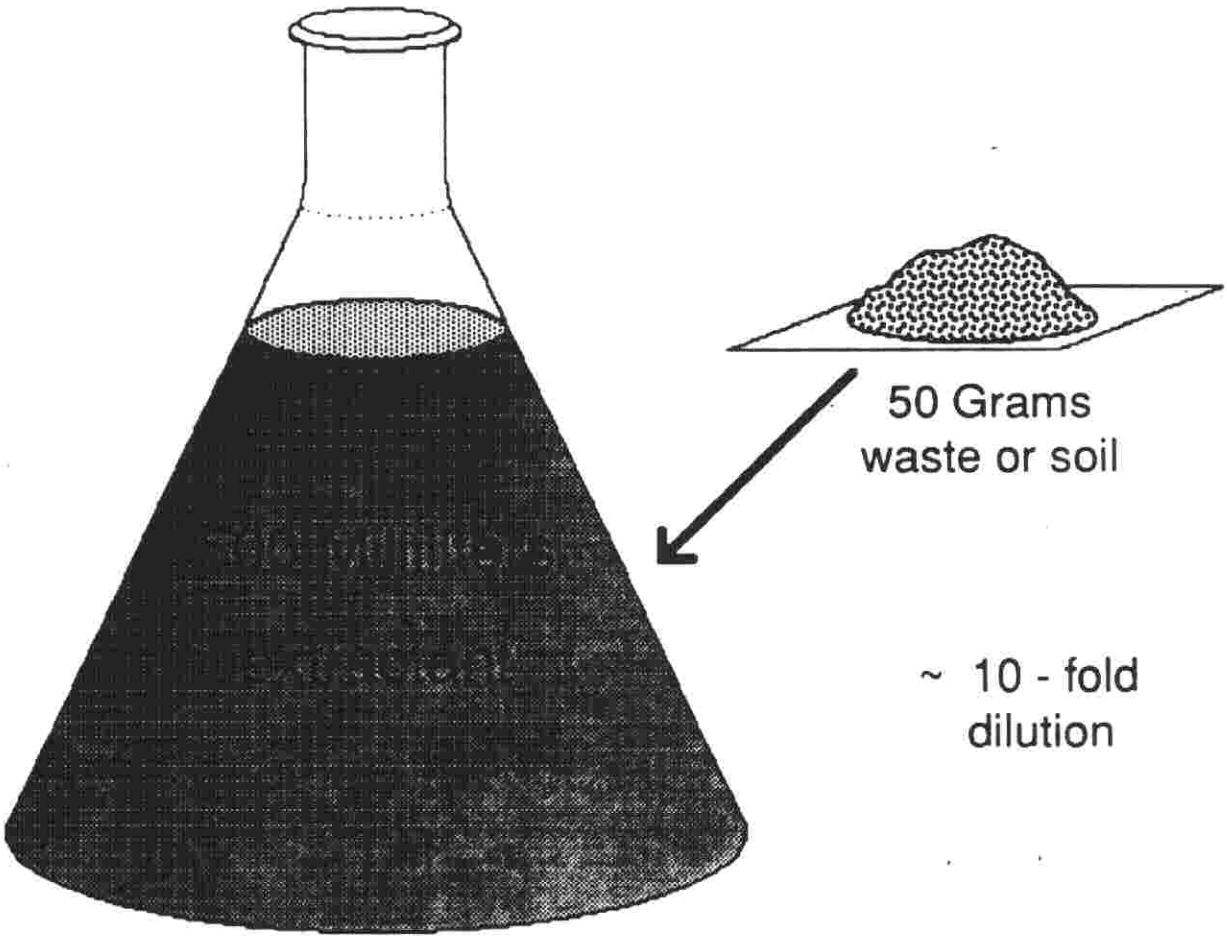
1) **perform WET using Zero Headspace Extraction Vessel and procedures outlined in draft of EPA "Toxicity Characteristic Leaching Procedure" (TCLP),** or

2) **calculate Total Designated Levels for comparisonwith total constituent concentrations.**

The Department of Health Services developed the WET procedure for use in determining whether sufficient amounts of extractable constituents are available to leach to ground water, and thereby impact human health, if the waste is discharged to a Class III (sanitary) landfill. The WET uses a citrate buffer solution with a pH of 5.0 to mimic the extraction capability of 'nonhazardous solid waste' leachate, which is often acidic. Acidic solutions are more capable than deionized water or some other neutral solution of extracting metallic and other constituents from a waste. If the proposed waste management scheme is co-

Figure 9

CALIFORNIA WASTE EXTRACTION TEST (WET)
TITLE 22, CCR, §66700



CONVERTING EXTRACTABLE CONCENTRATIONS FROM mg/kg TO mg/l:

Because of the dilution in the Waste Extraction Test,
Z milligrams per liter of extract is approximately equivalent
to Z × 10 milligrams per kilogram of waste or soil.

disposed with 'nonhazardous solid waste' in a Class III landfill, if the waste is to be discharged to some other potentially acidic environment, or if the waste itself is capable of generating acidic leachate (see *"Acid-Base Account"* below), the standard citrate buffer should be used in the WET. If the waste is not to be discharged to a Class III landfill with 'nonhazardous solid waste' or to some other potentially acidic environment and if the waste is not capable of generating acidic leachate, deionized water could be substituted for the citrate buffer extract solution in the WET to more accurately assess the leachability of waste constituents.

Another reason for choosing to perform a deionized water extraction on a solid waste is to determine the extractable concentrations of constituents or parameters for which the citrate buffer would interfere in the analysis. Common examples are hexavalent chromium (Cr VI), total dissolved solids (TDS), specific conductivity (EC), and pH. As mentioned in Subsection (e) of the WET procedure (see Appendix I), a deionized water extraction must be performed to determine extractable Cr VI concentrations in wastes. In the presence of the acidic citrate buffer, Cr VI is reduced to trivalent chromium (Cr III), thereby making analysis for Cr VI invalid. The citrate buffer contains dissolved solids and has a fixed pH of 5.0 that can prevent the assessment of TDS, EC, or pH contributed by the waste itself. Deionized water extraction should not replace citrate buffer extraction if the waste is to be discharged to a Class III landfill or some other acidic environment or if the waste itself is capable of generating acidic leachate. Deionized water extraction should be performed in addition to the citrate buffer extraction in these cases where information on extractable Cr VI, TDS, EC, or pH is desired.

Acid-Base Account

Even if the waste is not to be discharged to a Class III landfill with 'nonhazardous solid waste' or to some other potentially acidic environment, acidic leachate could be generated by the waste itself. This is particularly true of some mining wastes which contain pyritic minerals.[4] These sulfur containing minerals become oxidized when the waste materials are exposed to air for the first time. The oxidation process produces sulfurous acid (H_2SO_3), a major component of acid mine drainage. The acidic leachate so formed can readily mobilize toxic heavy metals in the mining waste. However, minerals such as calcium carbonate ($CaCO_3$) may also be present in the mining waste which have sufficient capacity to neutralize acid formed from pyrite oxidation. [Mining wastes will be discussed further in Chapter 5 below.] In order for the waste to be able to produce acid, the ability of the waste to generate acid must exceed its ability to neutralize acid over the life of the waste management unit in which the waste is to be placed.

The potential of a waste to produce acid is termed the "acid generation potential" (AGP), while the ability of a waste to neutralize acid is called the "neutralization potential" (NP). AGP may be expressed in pounds of $CaCO_3$ required to neutralize the acid formed by 1,000 pounds of waste; while NP may be expressed in pounds of $CaCO_3$ equivalents per 1,000 pounds of waste. When expressed in these terms, the ratio of NP to AGP is a measure of the overall ability of the waste to produce acid. Analytical procedures exist for determining AGP and NP, and thereby determining the overall acid-base account, of a waste.[5,6] Appendix II of this report contains procedures for determining the acid-base

account of a waste. A ratio of NP to AGP of less than 3:1 indicates that an acidic leachate may be formed, while a ratio of NP to AGP of 3:1 or greater indicates that an acidic leachate will probably not be formed by the waste. The selection of the 3:1 ratio, in which NP exceeds AGP, accounts for the greater leachability of many of the minerals responsible for NP (mainly carbonates) as compared with those responsible for AGP (mainly sulfides), and accounts for the uneven distribution of these minerals within a waste which may cause localized pockets of acid generation.

The results of the acid-base account would indicate which extraction solution should be used in the WET. The citrate buffer is appropriate for any waste which has a NP to AGP ratio of less than 3:1. Deionized water could be substituted for the citrate buffer for wastes having a NP to AGP ratio of 3:1 or greater. (In some cases, it may be appropriate to adjust the deionized water to the pH of local rainwater to be able to assess the resulting leachability of waste constituents from this increasingly important environmental factor.) The appropriateness of choosing deionized water may cross checked by performing other analytical procedures such as the use of the humidity cell method, which attempts to demonstrate acid generation in accelerated bench scale oxidation test.[6]

Analysis for Volatile Constituents

The current WET procedure cannot be used to accurately determine extractable concentrations of purgeable (volatile) constituents of a solid waste. Examples of these constituents include trichloroethylene, vinyl chloride and other volatile organic contaminants (VOCs) and organic lead compounds. Due to their high vapor pressures and relatively low solubilities in water, significant fractions of the concentrations of these constituents would be lost to the air space (head space) in the extraction vessel during the extraction procedure. Losses to the atmosphere would also occur during other portions of the waste and extract handling phases of the WET. For these reasons, soluble or extractable concentrations may not be used as an accurate measure of the potential threat to water quality posed by most volatile components of wastes. Total concentrations must be used.

However, recognizing the need for an extraction procedure for volatiles, the U.S. EPA has proposed a new test called the "Toxicity Characteristic Leaching Procedure" or TCLP.[7] This procedure includes a "Zero Headspace Extraction Vessel" in which extractions for volatile constituents could be performed without appreciable loss to the atmosphere. If these or other similar vessels become available for general use, they could be substituted for the standard vessel in the WET, making extraction for volatiles possible.

3.2 Water Quality Goals

The basis of the Designated Level Methodology is the assessment of concentrations of waste constituents which, if equalled or exceeded, could be mobilized and transported to ground and/or surface waters in amounts which would cause degradation of the quality of those waters. The assessment must, therefore, begin with the identification of the bodies of water which could be affected by a particular waste disposal and of numerical parameters indicative of existing water quality at the proposed site of waste disposal. These parameters will be called "water quality goals" in this report.

In most cases, background water quality — the concentrations of substances in natural waters which are unaffected by waste management practices — are appropriate for use as water quality goals. This is consistent with the establishment of "water quality protection standards" for indicator parameters and waste constituents which are reasonably expected to be in or derived from wastes discharged to waste management units, under §2552 of Subchapter 15, which also states:

> "The background concentrations of applicable indicator parameters and waste constituents at or near the new waste management unit before wastes are discharged shall be established as the water quality protection standards for the unit... For existing waste management units, the background concentration shall be determined from nearby wells beyond the influence of the unit or facility."

This Section of Subchapter 15 also cautions that the selection of background concentrations should take into consideration significant seasonal or long term water quality fluctuations and trends that are unrelated to the discharge of waste.

The non-degradation ideal is also the focal point of the State Water Resources Control Board's Resolution No. 68-16 "Statement of Policy With Respect to Maintaining High Quality of Waters in California". This resolution states that existing high water quality is to be protected even if some degradation in that water quality would not impair beneficial uses. Deviation from the non-degradation ideal is permitted if it can be demonstrated to the State that:

1) some degradation is in the best interest of the citizens of California; and

2) beneficial uses of the waters are not impaired.

If it is determined that some water quality degradation is in the best interest of the State, water quality goals may be selected by identifying 1) the present and probable future beneficial uses of waters which may be affected by the particular waste disposal and 2) numerical concentrations of waste constituents and indicator parameters allowable in the waters so that those uses are protected. The Water Quality Control Plan Reports ("Basin Plans") of the nine Regional Water Quality Control Boards or the California Ocean Plan [8] should be consulted to determine beneficial uses. Also cited in these plans are "water quality objectives" for several constituents of concern which, if not exceeded, will protect those uses. These "Basin Plan objectives" and several other numerical criteria and standards may be used as water quality goals for deriving Designated Levels. Water quality criteria and standards that are designed to protect a number of beneficial uses such as human health and welfare, aquatic life, agricultural use, and aesthetics may be found in the literature and are summarized below:

Human Health

- Primary Drinking Water Standards or Maximum Contaminant Levels (MCLs) in Title 22 of CCR, Division 4, Chapter 15, "Domestic Water Quality and Monitoring" [9] which have

been adopted by DHS for use in California;

Note: These values are derived in conjunction with technologic and economic factors and are, therefore, not purely health-based.

- State "Action Levels" published by the Sanitary Engineering Branch of DHS[10];

- Recommended Maximum Contaminant Levels (RMCLs)[11] promulgated by the U.S. EPA under the National Primary Drinking Water Regulations as the first step in establishing MCLs;

  Note: By law, these are purely health based values, and are set at "zero" for carcinogens.

- Quality Criteria for Water, 1986 ("Gold Book")[12] and the Ambient Water Quality Criteria volumes[13] (1980) published by EPA for the priority pollutants which contain No-Adverse-Effect Levels for non-carcinogens, 10^{-6} incremental cancer risk estimates for carcinogens, and other toxicity-based criteria;

- Quality Criteria for Water ("Red Book")[16] published by EPA in 1976 [superseded by Quality Criteria for Water, 1986 ("Gold Book")[12] and the Ambient Water Quality Criteria volumes[13] for the priority pollutants];

- Water Quality Criteria, 1972 ("Blue Book")[17] published by EPA in 1973 [superseded by Quality Criteria for Water ("Red Book")[16]];

- "Health Effects Advisories" published by the U.S. EPA, Office of Drinking Water[14] which include Suggested No Adverse Response Levels (SNARLs) for non-carcinogens and 10^{-6} incremental cancer risk estimates for carcinogens;

- Drinking Water and Health volumes 1, 3, 4, 5, 6, and 7 [15] published by the National Academy of Sciences which include Suggested No-Adverse-Response Levels or SNARLs [values are presented for some carcinogens which do not include consideration of the cancer risk posed by those chemicals] and 10^{-6} incremental cancer risk estimates;

- Proposition 65 No-Significant-Risk Levels (NSRLs) established by the Health and Welfare Agency in CCR Title 22 for known human carcinogens and reproductive toxins which may be converted into concentrations in water;

- Estimated Permissible Ambient Goals[18] published by EPA in 1977 as informal criteria;

  Note: These are estimated from occupational exposure to airborne pollutants and are, therefore, not very reliable. They should only be used if no other criteria are available.

Human Welfare

- Secondary MCLs (Drinking Water Standards) in Title 22 of CCR, Division 4, Chapter 15, "Domestic Water Quality and Monitoring" [9] which have been adopted by DHS;

- State "Action Levels" published by the Sanitary Engineering Branch of DHS[10] which contain taste and odor thresholds for some chemicals;

- Ambient Water Quality Criteria volumes[13] published by EPA in 1980 for the priority pollutants which contain taste and odor-based criteria for some chemicals;

Aquatic Life and Wildlife

- Quality Criteria for Water, 1986 ("Gold Book")[12] and the Ambient Water Quality Criteria volumes for the priority pollutants[13] (1980) published by EPA with updates for some chemicals published in 1985 [19];
  Note: 4-day average, 24-hour average, or chronic criteria should be used as water quality goals whenever available to protect the surface water resource for the long term.

- Quality Criteria for Water ("Red Book")[16] published by EPA in 1976 [superseded by Quality Criteria for Water, 1986 ("Gold Book")[12] and the Ambient Water Quality Criteria volumes[13] for the priority pollutants];

- Water Quality Criteria, 1972 ("Blue Book")[17] published by EPA in 1973 [superseded by Quality Criteria for Water ("Red Book")[16];

- Estimated Permissible Ambient Goals[18] published by EPA in 1977 as informal criteria;
  Note: These are estimated criteria and should only be used if no other criteria are available.

Agricultural Use

- Water Quality for Agriculture[16] published by the Food and Agriculture Organization of the United Nations in 1985;

Other Uses

- Water Quality Criteria [21] written by McKee and Wolf and published by the State Water Resources Control Board in 1963 which contains criteria for human health and welfare, aquatic life, agricultural use, industrial use, and various other uses.

A compilation of these water quality goals may be found in Appendix III to this report.

To protect the maximum number of beneficial uses, the most restrictive (lowest), applicable, and justifiable water quality goals should be selected for deriving Designated Levels. Due to the rapidly changing data base on the health and environmental effects of chemicals, caution should be observed in selecting among the various water quality criteria and standards to be sure that the most recent information is utilized. The original literature should be consulted whenever possible to determine the applicability and limitations of the criteria and standards being selected. Other government agencies, such as the California Department of Health Services, the California Department of Fish and Game, and the U.S. Environmental Protection Agency may be consulted for up-to-the-minute information.

It is common practice to rely on Primary MCLs as "enforceable standards". However, care should be taken in the application of Primary MCLs to the protection of **sources** of drinking

water. A common example of incorrect application is the use of the total trihalomethane (TTHM) MCL for the protection of ground water from chloroform. Chloroform is one of the four chemicals covered by the term "trihalomethanes". The TTHM standard of 100 μg/l is over 500-times greater than the 10^{-6} incremental cancer risk estimate for chloroform. EPA has stated that the MCL for TTHMs was based mainly on technology and economics.[22] Therefore, this standard does not clearly protect the beneficial use for domestic supply of waters of the State. The MCL for TTHMs was derived, for application to drinking water as it is delivered to consumers after disinfection by chlorination, by balancing the benefit provided by the chlorination process (elimination of pathogens in drinking water) with the health threat posed by the trihalomethane by-products of this process. In the case of contaminated ground water this type of cost/benefit balancing is not germain, and so the MCL does not apply to the protection of the ambient quality of domestic water supply sources. The 10^{-6} cancer risk estimate of 0.19 μg/l should be used as the measure of potential impairment by chloroform of the beneficial use of ground water for domestic supply. Staff of EPA, Region 9 has stated that the application of the 10^{-6} cancer risk estimate, instead of the TTHM MCL, as a water quality goal for chloroform in ground water appears to be consistent with the federal Clean Water Act and the recently adopted Safe Drinking Water Act.[23] and that the TTHM standard is not appropriate for protection of ambient water quality.[24]

In fact, virtually all primary MCLs are derived by balancing the technologic and economic concerns that are directly related to the use of water for domestic supply with the health effects information developed under the RMCL process. Thus primary MCLs are not necessarily reliable indicators of protection of beneficial uses of an ambient water resource and should not necessarily be relied upon as water quality goals in these situations. There are other instances where water quality criteria more stringent than MCLs are applied to protect the beneficial uses of a water resource. For example, it is common practice to require compliance with aquatic life criteria for heavy metal contaminants in surface waters that are often much lower than MCLs for the same contaminants.

Once it has been decided that some degradation in water quality will be permitted (i.e., background water quality is not used for water quality goals), other factors may require water quality goals to be set below water quality-related standards and criteria. Care should be taken to consider other dischargers in the area and the contribution to the degradation of water quality that each imposes. If one discharger is permitted through the disposal of his waste to degrade the water resource to just below the point where beneficial uses are impaired, then no additional capacity exists for further degradation by other discharges of waste. In addition, the knowledge of the health and environmental effects of chemicals or combinations of chemicals is constantly evolving. What is considered to be safe at or below 10 μg/l today may be found to be harmful at 1 μg/l tomorrow.

3.3 Calculating Designated Levels

Designated Levels are measures of the minimum concentrations of waste constituents which, upon accounting for environmental attenuation at the proposed site of discharge, have the potential to cause the water quality goals for the constituents to be equalled or exceeded in ground and/or surface waters. Designated Levels fall into two main types,

Soluble and Total. Soluble Designated Levels represent concentrations of **soluble** or **extractable** constituents in a solid waste (represented by the concentration of the constituent in the extract from the Waste Extraction Test) which threaten to degrade water quality if equalled or exceeded. Total Designated Levels represent **total** concentrations of constituents in a solid waste or **total** or **dissolved** concentrations of constituents in a liquid waste which threaten to degrade water quality if equalled or exceeded. The calculation of site-specific Soluble and Total Designated Levels for solid and liquid wastes is also discussed below.

Since their values are based upon site-specific environmental attenuation, the calculation of Designated Levels from water quality goals must include factors which account for the environmental processes that can alter a constituent's ability to reach waters of the State in sufficient amounts to cause an adverse impact.

3.3.1 Environmental Attenuation Factors

As constituents in a liquid waste or in leachate from a solid waste migrate through the environment from the place of waste discharge to surface or ground waters the opportunity exists for attenuation or reduction of the concentrations of these constituents. The degree of expected attenuation under reasonable worst-case conditions at the site of discharge may be approximated with "environmental attenuation factors" — the greater the degree of expected attenuation, the larger the factor. These factors may be used to transform water quality goals into site-specific Designated Levels, that is, concentrations of constituents **in the waste** that have the potential to degrade water quality at the site of discharge.

The degree to which waste constituent concentrations become attenuated as they migrate toward ground and/or surface waters is governed by a set of processes collectively termed "environmental fate". Environmental fate processes include adsorption of constituents to clay particles and organic matter in the soil, ionic or covalent binding of the constituents to soil components, filtration of larger constituents by fine-grained soils; chemical or biochemical degradation, volatilization to the atmosphere or to air spaces within the unsaturated or vadose zone, and dispersion and dilution with vadose zone waters, surface waters or ground water. The total quantity of a waste constituent applied to a site (i.e., mass loading) may be sufficient to saturate some of the key environmental fate processes at a site, rendering them unavailable to further attenuate waste constituent concentrations. Other constituents in the waste, such as organic solvents, may increase the expected mobility of the constituent being considered.

Some of the key **characteristics** that influence the environmental fate of waste constituents are shown in Figure 10. Several of these characteristics involve hydrogeologic information on the site of waste discharge, while others involve the environmental chemistry of the waste constituents themselves — how the constituents are expected to chemically interact with environmental characteristics.

Also shown in Figure 10 is how increases in the environmental characteristics effects the selection of an environmental attenuation factor. If **ground water** is threatened by waste

Figure 10

EXAMPLES OF ENVIRONMENTAL FATE CHARACTERISTICS WHICH INFLUENCE THE SELECTION OF ATTENUATION FACTORS

As the following characteristics increase...	Effect on Atten. Factor ↑	Effect on Atten. Factor ↓
For the Protection of Ground Water —		
• **Depth to Highest Ground Water** (including capillary fringe)	✓	
• **Net Recharge** (i.e., [rainfall] — [evaporation])		✓
• **Characteristics of the Vadose Zone:**		
Permeability and Porosity		✓
Clay Content	✓	
Organic Matter Content (for organics)	✓	
Ion Exchange Capacity and pH (for inorganics)	✓	
• **Pollutant Characteristics:**		
Polarity		✓
Ionic Strength (more positive)	✓	
Volatility (potential for vapor transport)		✓
Viscosity	✓	
Degradability / Biologic Activity	✓	
Octanol/Water Partition Coefficient (K_{ow})	✓	
• **Other Constituents that Could Increase Mobility**		✓
• **Topography** (Steepness of Terrain)	✓	
• **Total Pollutant Load** (Mass Loading)		✓
• **Volumetric Ground Water Flow Rate**	✓	
• **Uncertainty of the Data and Assumptions**		✓
For the Protection of Surface Waters —		
• **Distance from Drainage Courses**	✓	
• **Topography** (Steepness of Terrain)		✓
• **Pollutant Characteristics:**		
Volatility (loss to atmosphere)	✓	
Reactivity / Degradability	✓	
Polarity		✓
Octanol/Water Partition Coefficient (K_{ow})	✓	
• **Other Constituents That Could Increase Mobility**		✓
• **Initial Dilution Upon Reaching Surface Waters** (minimum surface water flow vs. maximum pollutant flow)	✓	
• **Interconnection of Ground and Surface Waters**		✓
• **Total Pollutant Load** (Mass Loading)		✓
• **Uncertainty of the Data and Assumptions**		✓

constituents, increases in the depth to ground water (thickness of the vadose zone), in the clay content, organic matter content, ion exchange capacity or pH of vadose zone materials, in the ionic strength, viscosity, degradability or octanol/water partition coefficient (the affinity of the chemical for octanol or soil organic matter versus its affinity for water) of the waste constituent, in the concentrations of solvents or other chemicals that can increase the permeability of soils or act as carriers for the constituent, in the steepness of the terrain, and in the rate of flow of ground water will cause the attenuation factor to be larger (greater attenuation). Increases in the net recharge rate (a driving force for movement of waste constituents), in the permeability or porosity of vadose zone materials, in the polarity or volatility of the waste constituent, and in the mass loading of waste constituents will cause the attenuation factor to be smaller (less attenuation as the constituent migrates to ground water). If **surface waters** are threatened by constituents in a waste, increases in the distance of travel from the site of waste discharge to surface water, in the volatility, reactivity, degradability or octanol/water partition coefficient of the waste constituent, in the concentrations of solvents or other chemicals that can increase the permeability of soils or act as carriers for the constituent, and in the amount of initial dilution that the waste or leachate would receive upon entering surface waters will cause the attenuation factor to be larger. Increases in the steepness of the terrain, in the polarity of the constituent, in the amount of interconnection of ground and surface waters, and in the total constituent loading will lower the attenuation factor.

Undoubtedly the most important characteristic that must be evaluated in the derivation of environmental attenuation factors is the relative uncertainty of the data and assumptions used to describe environmental fate processes. The more uncertainty involved in the estimation of environmental attenuation factors, the more the assumptions being used in their derivation should lean in the direction of underestimating the amount of attenuation expected to occur. In this way, a greater assurance of water quality protection is provided. The degree of uncertainty in the estimation of environmental attenuation should also be reflected in the amount of vadose zone and ground water monitoring that is required for a waste management unit. Greater uncertainty necessitates a greater monitoring effort to assure that the environmental fate analysis was protective of water quality.

Note: Because of the great uncertainty in environmental fate analysis, some regulators favor an approach for setting Designated Levels that does not consider any attenuation between the initial leachate or liquid waste and waters of the State. While this approach is surely protective of water quality, it does not appear to be feasible from an economic nor logistic point of view at the present time, since many more wastes would be found to be 'designated' and would require Class II or Class I disposal.

Site- and constituent-specific information regarding key environmental fate characteristics under reasonable worst-case conditions may be used to derive attenuation factors for specific waste constituents at the site. The DHS publication The California Site Mitigation Decision Tree Manual,[25] the EPA document Water Related Environmental Fate of the 129 Priority Pollutants,[26] The Soil Chemistry of Hazardous Materials by James Dragun,[35] Handbook of Environmental Data on Organic Chemicals by Karel Verschueren,[27] and the EPA publication DRASTIC: A Standardized System for Evaluating Ground Water Pollution Potential Using Hydrogeologic Settings [28] contain useful information and

procedures that can be used to assess the fate of chemicals in the environment and estimate environmental attenuation factors for specific waste constituents and site conditions.

Detailed information on many environmental fate characteristics may prove difficult or impractical to obtain. Therefore, the analysis may be approached initially in a simplified manner, by using more easily obtainable information on some of the key characteristics and conservative assumptions about the remaining characteristics to approximate the minimum expected attenuation. For example, in the analysis of the threat posed to surface waters the lowest anticipated initial dilution of the waste or leachate into surface waters can be used as a measure of attenuation. If this type of simplistic analysis can clearly demonstrate that waste constituents cannot adversely impact water quality, then further and more detailed analysis may be unnecessary. If a simplified analysis gives inconclusive results or shows that the potential for water quality degradation may exist, the waste discharger may wish to obtain detailed information on heretofore undetermined environmental fate characteristics in order to refine the analysis.

In many cases, resources may not permit a detailed environmental fate analysis for the selection of attenuation factors. This is especially true where a discharger requires a preliminary idea of how a waste will be classified. For these cases it is proposed that a "generic" environmental attenuation factor be chosen in a manner similar to that used by DHS in the setting of hazardous STLCs. The CAM SOR [3] justifies the use of a 100-fold attenuation factor, based on studies conducted by Batelle Laboratories and EPA.[29,30] Both studies stress that the degree of attenuation of waste constituents depends on waste- and site-specific conditions, as discussed above. It is, therefore, impossible to select an attenuation factor that will be appropriate for all wastes constituents or all disposal sites and situations. Expected landfill-to-useable ground water attenuations cited by EPA range from one to 1,000-fold, based on mathematical models and actual field data. Both the Batelle and EPA documents selected a 100-fold attenuation factor to conservatively represent average attenuation of waste constituents as leachate moves to an underground source of drinking water; however, neither study provides detailed descriptions of which waste- and site-specific conditions are best approximated by the 100-fold factor.

In selecting a "generic" environmental attenuation factor for purposes of deriving designated levels, the 100-fold factor should be used in those disposal situations which provide an "average" degree of natural protection for water quality from the discharge of wastes under reasonable worst-case conditions. An example of such an average disposal situation would be a landfill in the alluvium of the Central Valley with a significant depth (i.e., greater than 30 feet) of soil containing appreciable and continuous clay or silty-clay strata between the base of the landfill and ground water. For sites that provide less than this "average" amount of water quality protection (e.g., high ground water or more highly permeable geologic materials—sandy soils or fractured rock), a lower environmental attenuation factor, such as one (1) or ten (10) should be chosen. Where a very low degree of natural water quality protection may exist or for situations in which the mass loading of waste constituents is likely to saturate environmental attenuation processes (e.g., the discharge of large volumes of a liquid waste to a surface impoundment continuously over many years in an area with moderately permeable soils), a factor of one (1) should be used. A factor of 1,000 may be appropriate in areas that provide a very high degree of water

quality protection or for constituents that are known to have a much greater than average degree of environmental attenuation. [Examples of such constituents are free cyanide in surface waters, copper, zinc, and DDT under common environmental conditions [3,26].]

Whenever sufficient site- and waste-specific data can be obtained, a more thorough analysis of environmental fate should be substituted for this "generic" attenuation factor approach. It is the responsibility of the waste discharger to provide this analysis.

3.3.2 Designated Levels for Liquid Wastes

The Total Designated Level for a constituent of a liquid waste is calculated by multiplying the water quality goal by the environmental attenuation factor that takes into account reasonable worst-case site- and waste-specific conditions at the proposed place of waste discharge.

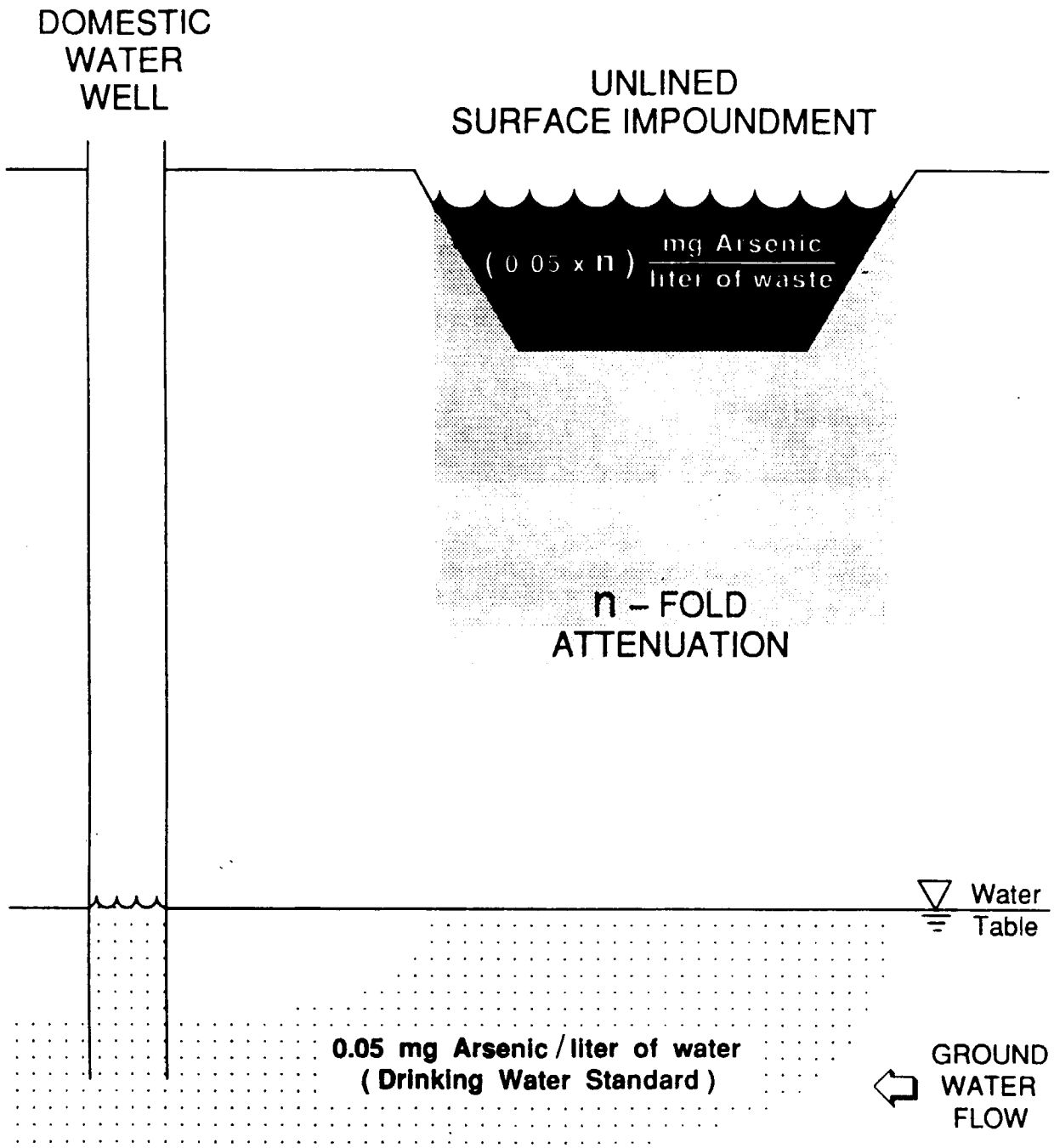
$$\text{Total Designated Level for constituent of a liquid waste (mg/l of waste)} = \text{Water Quality Goal (mg/l)} \times \text{Environmental Attenuation Factor} \qquad [1]$$

Figure 11 presents an example of the disposal of a hypothetical liquid waste to an unlined surface impoundment. In this example, the constituent of concern in the waste is arsenic and the potential threat to ground water is being considered. Ground water at this site has the potential for use as domestic supply. The Primary MCL for arsenic of 50 µg/l (0.05 mg/l) has been chosen as the water quality goal, protective of this beneficial use. By environmental fate analysis, the soils between the base of the impoundment and the highest anticipated elevation of ground water have been estimated to provide a minimum of "n"-fold attenuation for arsenic. The environmental attenuation factor is, therefore, equal to "n". The disposal of this waste is proposed to occur over a two year period; thus, the attenuative processes for arsenic in the soil are not expected to become saturated. The Total Designated Level for arsenic in the liquid waste discharged to this hypothetical impoundment is, therefore, equal to $(0.05 \times n)$ mg/l. If analysis of the waste shows that its dissolved arsenic concentration is equal to or greater than $(0.05 \times n)$ mg/l, the waste will not receive sufficient attenuation as it migrates from the impoundment to ground water and the resulting concentration of arsenic in ground water may exceed the Primary MCL, thus impairing the beneficial use of the water for domestic supply. This waste should, therefore, be classified as a 'designated waste' and the impoundment should be required to meet Class II surface impoundment construction standards. If the arsenic concentration in the waste is below $(0.05 \times n)$ mg/l, the waste does not have the potential to degrade ground water quality and would be classified as an 'inert waste' for this site. (Obviously, a liquid waste may not be classified as a 'nonhazardous solid waste'.)

If the arsenic concentration in the waste is close to but does not exceed $(0.05 \times n)$ mg/l, some impoundment construction requirements, such as a single clay liner, may be prudent to ensure that sufficient attenuation exists. This would be especially important if questions exist about the representativeness of the waste sampling and analysis or if the waste characteristics are expected to vary significantly over the period of time that the discharge will occur.

Figure 11

TOTAL DESIGNATED LEVEL FOR A CONSTITUENT OF A LIQUID WASTE



3.3.3 Designated Levels for Solid Wastes

The goal in calculating Designated Levels for a solid waste is to determine concentrations of **soluble** constituents **in the waste** above which leachate would be able to carry them to ground or surface waters in amounts that would cause water quality goals to be exceeded in those waters. Figure 12 illustrates a scenario of how soluble/extractable constituents of

solid waste in an unlined landfill or waste pile could impair water quality. As moisture from infiltrating rainfall or from the waste itself percolates through the solid waste, soluble constituents are dissolved in the liquid phase. In this way leachate accumulates soluble waste constituents until it reaches the base of the landfill or waste pile. At that point, this "initial leachate" poses a water quality threat that is similar to that posed by the liquid waste considered in Section 3.3.2 above. The same environmental fate processes and attenuation factors that govern the potential impact of constituents of a liquid waste apply to constituents of the "initial leachate" from a solid waste. Therefore, the concentrations of constituents in the "initial leachate" which have the potential to degrade water quality are equal to the Total Designated Levels for constituents of a liquid waste. Therefore, from equation [1],

Concentration of Constituent in "Initial Leachate" (mg/l) that could degrade water quality	=	Water Quality Goal (mg/l)	×	Environmental Attenuation Factor	[2]

At this point, an assumption is made that the concentrations of **soluble** constituents in the waste itself (in mg/kg of waste) prior to leaching are numerically equivalent to their concentrations in the "initial leachate" (in mg/l of leachate) formed from the waste. Therefore, from equation [2],

Soluble Concentration of Constituent in Waste (mg/kg of waste) that could degrade water quality	=	Water Quality Goal (mg/l)	×	Environmental Attenuation Factor	[3]

As explained in the CAM SOR,[3] concentrations in the "initial leachate" (in mg/l of leachate) could be lower, but could also exceed the soluble concentrations in the waste itself (in mg/kg of waste).

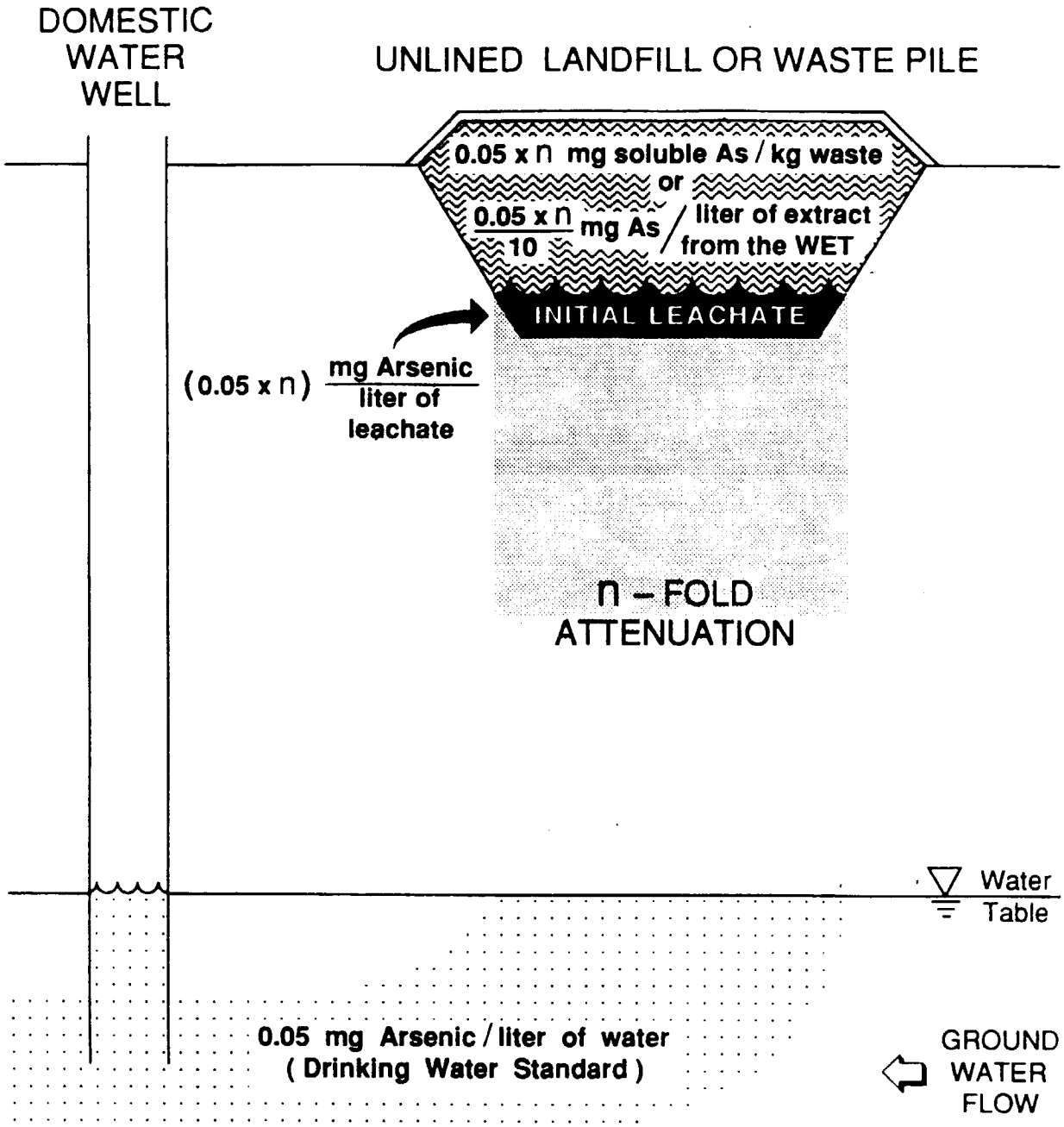
*Note: Concentrations of constituents in the "initial **leachate**" should not be confused with concentrations of constituents in **extract** from the Waste Extraction Test. They are not the same. Concentrations of constituents in the "initial leachate" are the result of the **accumulation** of constituents from the waste as moisture migrates through a landfill or waste pile. Concentrations of constituents in the extract from the WET are the result of a specific laboratory procedure where waste constituents are extracted from a solid waste by an extract solution under a controlled set of circumstances. The extract from the WET is, therefore, not a simulation of the "initial leachate", but a measure of the **amount of waste constituents** that may be leached from the waste in a landfill.*

Soluble Designated Levels

Extractable concentrations from the Waste Extraction Test are expressed in milligrams per liter (mg/l) of extract, rather than milligrams per kilogram (mg/kg) of waste. Soluble Designated Levels for constituents of a solid waste should also be expressed in mg/l of extract so that direct comparison with results from the WET may be made. However, conversion from the units of mg/kg of waste to mg/l of extract must take into account the 10-fold dilution in the WET procedure as explained in Section 3.1.2, *"Determining*

Figure 12

SOLUBLE DESIGNATED LEVEL FOR A CONSTITUENT OF A SOLID WASTE



Extractable Concentrations", above. Therefore, an expression for the Soluble Designated Level for a constituent of a solid waste may be derived from equation [3].

$$\text{Soluble Designated Level for a Constituent of a Solid Waste (mg/l of WET extract)} = \text{Water Quality Goal (mg/l)} \times \text{Environmental Attenuation Factor} \div 10 \qquad [4]$$

Figure 12 shows these calculations for a solid waste containing soluble arsenic. The water quality goal has been chosen to be equal to the Primary MCL of 0.05 mg/l and the site-specific environmental attenuation factor has been determined to be equal to "n". The concentration of arsenic in the "initial leachate" that has the potential to degrade ground water quality is calculated from equation [2], to be (0.05 × n) mg/l of leachate. The concentration of soluble arsenic in the waste that has the potential to degrade water quality is calculated from equation [3] to be(0.05 × n) mg/kg of waste. The Soluble Designated Level for arsenic in the solid waste at this site is calculated, from equation [4], to be (0.05 × n ÷ 10) mg/l of extract from the WET or (0.005 × n) mg/l. A solid waste for which the concentration of arsenic in the WET extract exceeds (0.005 × n) mg/l would be classified as a 'designated waste' and the landfill or waste pile would be required to provide Class II containment under Subchapter 15.

Leachability Factors and Total Designated Levels

If extractable concentrations of a solid waste cannot be determined for particular constituents, such as volatile organics, analyses for total constituent concentrations are usually possible. Under these circumstances, Total Designated Levels must be calculated for comparison with total constituent concentrations in the waste, using available information on the leachability of the constituents under worst-case conditions at the site of waste discharge. As shown in Figure 13, only a certain fraction of the total constituent concentration is available for leaching from the waste and for uptake by organisms upon which the constituent would have a toxic or deleterious effect. The remainder of the constituent concentration is immobile or unavailable for leaching due to such factors as encapsulation in the waste matrix, chemical bonding, or other molecular interactions within the waste. Information on the fraction of leachable constituent under reasonable worst-case conditions at the proposed site of discharge may be used to derive a "leachability factor". The leachability factor is equal to the total constituent concentration (leachable plus non-leachable) divided by the leachable constituent concentration, in other words, the reciprocal of the fraction of the constituent concentration that is leachable.

$$\text{Leachability Factor} = \frac{\text{Total Constituent Concentration}}{\text{Leachable Constituent Concentration}}$$

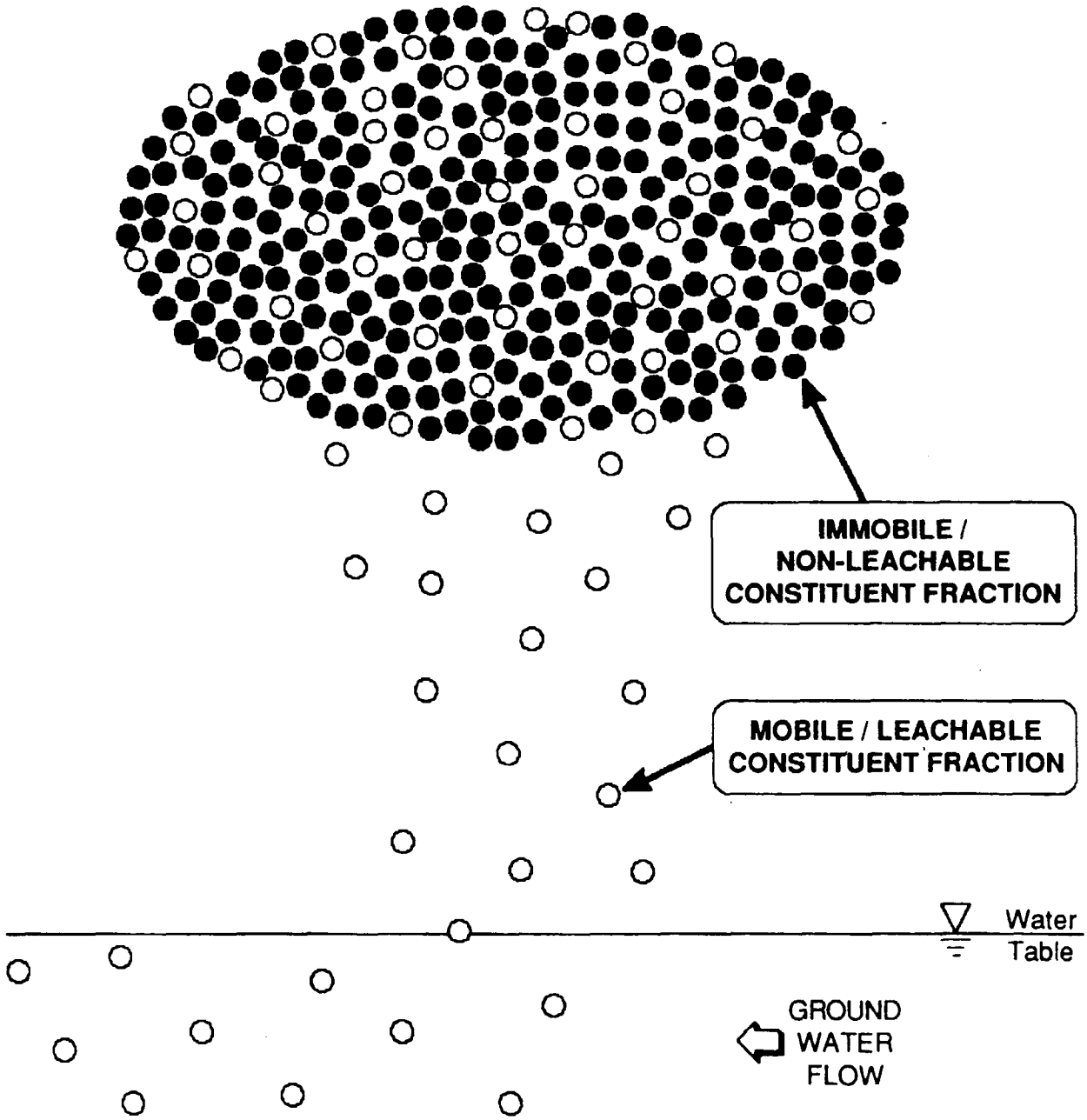
$$= 1 / (\text{Leachable Constituent Fraction}) \qquad [5]$$

For example, if it is known that for a particular constituent in a waste, reasonable worst-case conditions at the proposed site of discharge are able to mobilize one tenth (1/10) of the total concentration of the constituent, the leachability factor would be equal to ten (10).

Usually, when extractable concentrations of solid waste constituents cannot be determined, information on the leachable fraction is also unavailable. In these cases, the leachability factor must be approximated. The CAM SOR, in deriving TTLCs from STLCs for "persistent and bioaccumulative toxic substances", uses a leachability factor [called the "bioavailability factor" in that document] of 100 for toxic inorganic constituents and 10 for toxic organic constituents. The reason for this difference is explained as follows:

Figure 13

A SIMPLE VIEW OF THE LEACHABILITY FACTOR



"The organic substances...are generally artificial. Their occurrence in nature is negligible. None are essential nutrients to humans or animals. Accordingly, humans and animals have developed few natural defenses to these substances. Most are much more bioaccumulative and more toxic than the inorganic substances..." [3]

The "persistent and bioaccumulative toxic substances" for which TTLCs were derived fall into several chemical classes, including heavy metals (e.g., arsenic and mercury), organometallics (lead compounds, organic) base/neutral extractable compounds (e.g., chlordane, lindane and toxaphene), acid extractable compounds (pentachlorophenol), phenoxy acids (2,4,5-trichlorophenoxyacetic acid),, and volatile organic compounds (trichloroethylene). Most of the waste constituents that have the potential to degrade water quality (and will, therefore, be considered in the classification of wastes) fall into one or more of these chemical classes. For this reason, it is recommended that the "generic" 10-fold leachability factor for organics and 100-fold leachability factor for inorganics be used in situations where information on the leachable constituent fraction is unavailable.

The Total Designated Level for a constituent of a solid waste may be calculated by multiplying the Soluble Designated Level by the leachability factor. However, since the Total Designated Level is to be expressed in units of milligrams of constituent per kilogram of waste (mg/kg), the Soluble Designated Level from which it is calculated must also be expressed in these units. Due to the 10-fold dilution in the WET,

$$\begin{array}{c}\text{Soluble Designated Level}\\ \text{for a Constituent of a Solid}\\ \text{Waste (mg/kg of waste)}\end{array} = \begin{array}{c}\text{Soluble Designated Level}\\ \text{for a Constituent of a Solid}\\ \text{Waste (mg/l of WET extract)}\end{array} \times 10 \qquad [6]$$

The Total Designated Level for a constituent of a solid waste is, therefore, calculated as follows:

$$\begin{array}{c}\text{Total Designated Level}\\ \text{for a Constituent}\\ \text{of a Solid Waste}\\ \text{(mg/kg of waste)}\end{array} = \begin{array}{c}\text{Soluble Designated Level}\\ \text{for a Constituent}\\ \text{of a Solid Waste}\\ \text{(mg/l of WET extract)}\end{array} \times \begin{array}{c}\text{Leachability}\\ \text{Factor}\end{array} \times 10 \qquad [7]$$

By combining equations [4] and [7], the Total Designated Level for a constituent of a solid waste may be expressed in terms of the water quality goal.

$$\begin{array}{c}\text{Total Designated Level}\\ \text{for a Constituent}\\ \text{of a Solid Waste}\\ \text{(mg/kg of waste)}\end{array} = \begin{array}{c}\text{Water}\\ \text{Quality}\\ \text{Goal}\\ \text{(mg/l)}\end{array} \times \begin{array}{c}\text{Environmental}\\ \text{Attenuation}\\ \text{Factor}\end{array} \times \begin{array}{c}\text{Leachability}\\ \text{Factor}\end{array} \qquad [8]$$

A solid waste with total constituent concentrations greater than their Total Designated Levels would be classified as 'designated wastes' and would be required to have Class II containment at the site of waste discharge.

3.3.4 Summary of Designated Level Calculations

The **Total Designated Level** for a constituent of a **liquid waste**, expressed in milligrams of total or dissolved constituent per liter of waste (mg/l of waste), is equal to:

Water Quality Goal (mg/l) × Environmental Attenuation Factor

The **Soluble Designated Level** for a constituent of a **solid waste**, expressed in milligrams of constituent per liter of extract from the Waste Extraction Test (mg/l of WET extract), is equal to:

Water Quality Goal (mg/l) × Environmental Attenuation Factor ÷ 10

The **Total Designated Level** for a constituent of a **solid waste**, expressed in total milligrams of constituent per kilogram of waste (mg/kg of waste) is equal to:

Soluble Designated Level × Leachability Factor × 10 *or*

Water Quality Goal (mg/l) × Environmental Attenuation Factor × Leachability Factor

If the total concentration of a constituent of a solid waste equals or exceeds the Total Designated Level but the extractable concentration of the constituent does not exceed the Soluble Designated Level, the waste should **not** be classified as a 'designated waste', since it is the extractable or soluble constituent concentration that has the potential to adversely impact water quality.

If the **total** concentration of a constituent in a solid waste is less than ten (10) times the Soluble Designated Level for the constituent, it would be impossible for the extractable constituent concentration from the WET to equal or exceed the Soluble Designated Level; therefore, extraction testing would be unnecessary and the waste would not be considered a 'designated waste'. This is true because if all of the constituent was soluble, its concentration would be diluted by ten-fold in performing the WET and the resulting extractable concentration (in mg/l of extract) would be one-tenth (1/10) of the total concentration (in mg/kg of waste) prior to extraction.

Note: Because the calculation of Total Designated Levels for solid wastes introduces an additional degree of uncertainty in the form of the leachability factor, extractable concentrations of solid waste constituents from the WET should be determined and compared with Soluble Designated Levels whenever possible.

Note: In certain situations, a calculated Designated Level may fall below the concentration that is detectable using currently available analytical methods. In such cases, the Designated Level should be set at the "limit of detection" (i.e., if the constituent is detected, it is assumed to exceed the Designated Level). Care should be taken to specify that the lowest acceptable method detection limit must be achieved by the laboratory.

Chapter 4 CUMULATIVE EFFECTS OF COMBINATIONS OF CONSTITUENTS

When several chemicals of concern are present in a particular waste, their interactive environmental/health effects—either additive, antagonistic, or synergistic—should be considered. However, data on the cumulative effects of chemicals is generally not available in the literature. As a conservative rule, the potential water quality impact of several constituents that manifest their effects in the same or similar manner should be assumed to be additive. Constituent groups for which this rule would likely apply include primary carcinogens, organophosphate and carbamate pesticides, halogenated organic pesticides, organic solvents, petroleum hydrocarbons, and heavy metals.

Under the additivity assumption, the waste would be considered to be a 'designated waste' if the sum of the quotients obtained by dividing the concentration of each constituent by its Designated Level is greater than 1.0.[31]

$$\text{if } \sum_{i=1}^{n} \frac{(\text{Concentration of Constituent})_i}{(\text{Designated Level for Constituent})_i} > 1.0, \quad \text{then the waste is a 'designated waste'} \qquad [9]$$

This criterion could require the classification of a waste as 'designated' even if the concentrations of individual constituents are all below their respective Designated Levels. This indicates that even if no potentially adverse water quality impact is posed by individual constituents, the combination of constituents does have the potential to impair beneficial uses of waters of the State.

For example, consider a liquid waste that contains four carcinogenic volatile organic constituents in the following concentrations:

	Measured Concentration in the Waste	Hypothetical Designated Level
1,2-Dichloroethane	50 µg/l	100 µg/l
Tetrachloroethylene	250 µg/l	400 µg/l
Trichloroethylene	400 µg/l	500 µg/l
Vinyl chloride	120 µg/l	200 µg/l

Each constituent is below its individual Designated Level, however...

$$\frac{50}{100} + \frac{250}{400} + \frac{400}{500} + \frac{120}{200} = 2.5 \qquad [10]$$

On the basis of cumulative carcinogenic risk ($\Sigma > 1.0$), this waste should be classified as a 'designated waste'.

Chapter 5 MINING WASTES

Because mining wastes are usually not discharged together with other wastes and because the location of disposal often must be close to the area being mined, Subchapter 15 uses different terms to classify these wastes. However, because of similar properties and class definitions, they can be compared to the classifications of other wastes as follows:

Mining Waste		Other Wastes
Group A	=	'hazardous'
Group B	=	'designated'
Group C	=	'inert'

Mining wastes are to be discharged to mining waste management units classified as Class A, Class B, and Class C, respectively.

The hazardous waste management regulations of Title 22 of CAC determine the boundary between Group A and Group B mining wastes. The Designated Level Methodology may be used to define the boundary between Group B and Group C mining wastes. For determining whether a mining waste is Group B or Group C, deionized water (in some cases, adjusted to the pH of local rainfall) may be substituted for the citrate buffer in the WET only where mining wastes have been shown not to be capable of generating acidic leachate **and** where the disposal environment will be neutral or basic, pH ≥ 7.0 (see *"Determining Extractable Concentrations"* and *"Acid-Base Account"* in Section 3.1.2 above).

Chapter 6 SLUDGE AND ASH

§2523(c) and (d) of the "Discharges of Waste to Land" regulations in Subchapter 15 [2] indicate that dewatered sewage and water treatment sludges and incinerator ashes "may be" discharged to a Class III landfill if the Department of Health Services determines that the waste need not be managed as 'hazardous waste' and, for sludges, if certain moisture controlling conditions are met in the landfill. This wording appears to preclude the classification of these wastes as 'designated wastes'. However, legal staff of the State Water Resources Control Board has stated that Regional Boards may classify these wastes as 'designated' if they determine that it is necessary to protect water quality.[32] Concurrence is found in §2510(a) of Subchapter 15, which states:

> "Requirements of this subchapter are minimum standards for proper management of each waste category. Regional boards may impose more stringent requirements to accommodate regional and site-specific conditions."

Concurrence is also found in recent correspondence from the Executive Office of the State Water Resources Control Board, which states:

> "...the Regional Boards may, on a case-by-case basis, determine that certain nonhazardous sewage sludges must be discharged to a Class II landfill. Such sludges must meet the criteria of a designated waste as stated in Section 2522(a) of the regulations on waste discharge to land."

A memorandum from the Executive Director of State Board to the Regional Board Executive Officers[34] states:

> "Until we more thoroughly understand what occurs in waste management units as a result of...ongoing studies and monitoring, we should continue to allow disposal of municipal wastewater sludge in those Class III waste management units where problems are not evident or evidence does not exist that a particular problem is likely to occur. Exceptions must be justified on the basis of specific technical evaluations of the site and the waste in accordance with the present language of Subchapter 15."

The Designated Level Methodology can provide this technical waste- and site-specific evaluation. Where the evaluation indicates that waste constituents have the potential to cause water quality degradation, non-hazardous ashes and sludges should be classified as 'designated wastes'. As explained in Chapter 3 of this report, the classification would apply specifically to a particular waste and a particular site. Thus, not all sludges and ashes are expected to be classified as 'designated wastes' under this methodology and what is classified as 'designated' may not be so classified at a different disposal site that is more protective of water quality. As shown in Chapter 7 below, disposal in a Class I or Class II unit is not the only option for the discharge of a sludge or ash waste that is classified as 'designated'.

Chapter 7 RE-USE OF 'DESIGNATED WASTES'

Under the Subchapter 15 regulations,[2] disposal at a Class I or Class II waste management unit is not the only option for the discharge of a waste which has been classified as 'designated'. Exemptions listed in §2511 of the regulations permit the re-use of a 'designated waste', provided that the use does not threaten to degrade water quality. A waste-, use-, and site-specific evaluation must be made to determine whether waste constituents would be available in concentrations that could cause water quality goals to be exceeded and beneficial uses to be impaired.

7.1 Soil Amendments

§2511(f) permits the re-use of a waste as a soil amendment under certain conditions. Re-use as a soil amendment may provide a lower cost alternative to Class I or Class II disposal for such wastes as sewage treatment sludges and incinerator ashes. A waste that contains constituents in excess of Designated Levels may still be used for this purpose provided that the following conditions are met:

1) the waste is not 'hazardous';

2) loading rates of the waste to the soil are such that constituent concentrations in soils remain below Designated Levels for the site (i.e., the resulting concentrations in soil will not pose a threat to ground or surface water quality) and below levels which would be injurious to plants or crops or, through plant uptake, to consumers of crops from the site;

3) waste application is controlled to prevent direct constituent release to surface waters via tail water from the field; and

4) the waste is shown to provide a benefit for the soil on which it is applied, such that the re-use does not simply constitute disposal.

A site monitoring program should be implemented to ascertain compliance with points (2) and (3) above.

7.2 Recycling

Recycling of 'designated wastes' is permissible under §2511(h) of Subchapter 15. A similar site-, waste-, and use-specific analysis would be necessary to demonstrate that water quality is protected and that the recycling is not just disposal. The party proposing the recycling should provide this analysis to the appropriate Regional Water Quality Control Board for review and approval.

Chapter 8 CLEANUP LEVEL DETERMINATION AND CONTAMINATED SITE MITIGATION

One of the most crucial determinations made in the cleanup of a contaminated site is what concentrations of contaminants can safely remain without the need for further remedial action; in other words, "how clean is clean?". These concentrations are often called "cleanup levels". Ideally, all contaminants should be removed and the site returned to "background" conditions; however, removing every molecule of a contaminant is often technologically infeasible and may not be the best use of economic resources. A method for determining what is safe to leave at a site is, therefore, necessary.

It is important at the outset of cleanup to establish goals for the mitigation effort. Ground water should be cleaned to the level where beneficial uses are restored (i.e., water quality goals are not exceeded). Soils should be removed or mitigation provided such that the remaining contaminants do not pose a threat to water quality, or to human health or the environment through direct or indirect pathways. If naturally occurring concentrations of constituents in waters or soils at the site ("background") exceed these cleanup criteria, the background levels should guide the cleanup effort. If background levels are lower than cleanup criteria, cleanup to background levels may also be appropriate if technologically and economically feasible (see the discussion of the State Water Resources Control Board Resolution No. 68-16, "Statement of Policy With Respect to Maintaining High Quality of Waters in California" in Section 3.2 above).

Under the Health and Safety Code, §25356.1, DHS and the Regional Water Boards share the responsibility for remedial action at sites contaminated with toxic and hazardous substances. Subsection (c) of that section lists six factors that must be considered in the development of a remedial action plan (RAP) for such sites. These factors are:

1) health and safety risks at the site;

2) the effect of contamination or pollution levels upon present, future and probable beneficial uses of contaminated, polluted, or threatened resources;

3) the effect of alternative remedial action measures on the reasonable availability of ground water resources for present, future, and probable beneficial uses;

4) site specific characteristics;

5) cost effectiveness; and

6) potential environmental impacts.

The terms "present, future, and probable beneficial uses" clearly reflect wording of the Porter-Cologne Water Quality Control Act (Water Code, Division 7) and mandate the direct involvement of the Regional Water Boards in the cleanup and/or prevention of water quality impacts from contaminated sites.

The Department of Health Services has recently developed extensive technical guidance on cleanup level determination for the prevention of toxicologic impacts on humans and other "biological receptors of concern". The procedures in this guidance, entitled The California Site Mitigation Decision Tree Manual,[25] reflect the legislative mandates that govern the site mitigation activities of DHS and, to a large extent, those of the U.S. EPA. However, the legislative mandate to protect all present and probable future beneficial uses of waters of the State, contained in the Porter-Cologne Water Quality Control Act and policies promulgated thereunder, require the State and Regional Water Boards to approach site mitigation from a somewhat different position. The three main areas of difference between the DHS and Water Board approaches to the cleanup question are summarized in Figure 14. The State and Regional Boards must prevent even non-toxicologic endpoints of contamination (e.g., taste and odor, recreation impairment) and endpoints that do not involve biological receptors (e.g., industrial use). The State and Regional Boards may require cleanup to levels below those that appear to protect all beneficial uses of water in order to account for the incompleteness of our current knowledge of environmental fate processes and the effects of contaminants as well as to address the allocation of water resources among potential users (i.e. if an individual is permitted to contaminate a body of water up to the water quality goal, there exists no room for additional contamination). Finally, the mandate to protect **probable future** uses of water require the State and Regional Boards to seek cleanup of even on-site waters to levels that will permit their future use.

For the reasons stated above, it is necessary for the State and Regional Boards to have a methodology to determine cleanup levels from a perspective of beneficial use protection. The Designated Level Methodology can fill this need. The threat to water quality posed by constituents of a contaminated soil is similar to the threat posed by constituents of a solid waste in an unlined landfill or waste pile, as seen by comparing Figures 12 and 15. These two situations share the same environmental fate processes that govern constituent attenuation and the same goal of beneficial use protection. By applying analytical procedures relevant to reasonable worst-case conditions at the site to determine the concentrations of constituents that are potentially available for migration to water (see Section 3.1 above) and by deriving site-specific Designated Levels for constituents of contaminated soils, the necessity for cleanup or mitigative measures for water quality protection should be apparent.

In many cases, the exceedance of Designated Levels by constituents of contaminated soils does not necessitate soil removal and re-disposal. It does indicate that mitigation measures are necessary to prevent potential water quality impacts.

As in waste classification, Designated Levels derived for use as cleanup levels should reflect site- and constituent-specific characteristics whenever possible. The water quality goals used in the assessment must be applicable to the present and probable future beneficial uses of the water resource being protected or cleaned-up (see Section 3.2 above). To reduce the level of uncertainty, extractable constituent concentrations from the soils should be compared with Soluble Designated Levels whenever practicable. The selection of extractant (citrate buffer or deionized water) should reflect the potential for acidic conditions at the site. Finally, care should be taken to account for the combined effects of

Figure 14

MAJOR DIFFERENCES BETWEEN THE DHS AND WATER BOARD APPROACHES TO CLEANUP WITH RESPECT TO WATER QUALITY PROTECTION

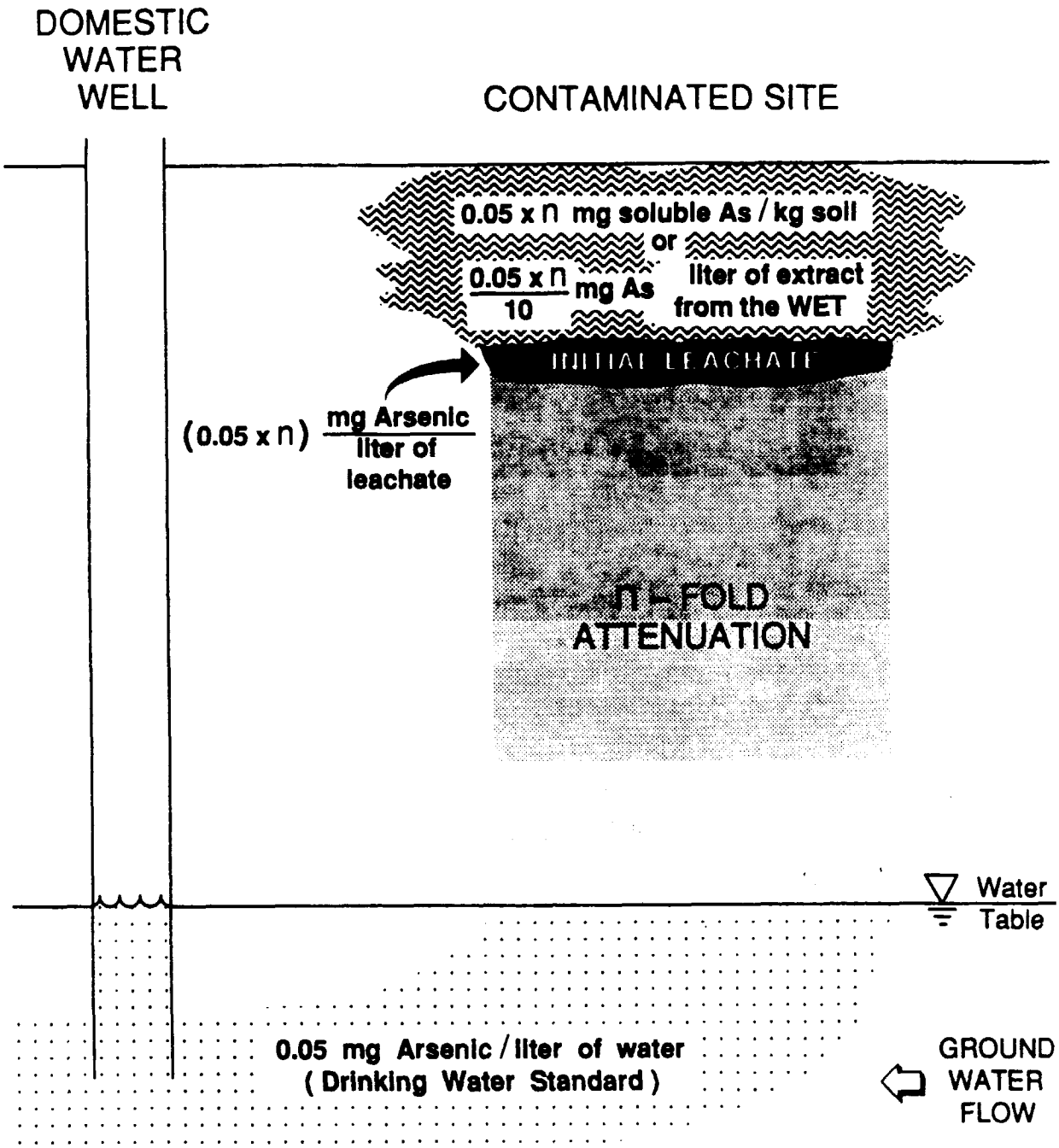
	DEPARTMENT OF HEALTH SERVICES	STATE & REGIONAL WATER BOARDS
End points addressed:	Toxicologic effects on humans and other biological receptors.	Any impact on present or probable future beneficial uses of water, including **non-toxicologic effects** on biological receptors and effects on **non-biological endpoints**.
What criteria are applied:	Threshold effect level for non-genotoxic (non-mutagenic, carcinogenic or teratogenic) agents. 10^{-6} risk level for genotoxic agents.	In the initial assessment, **background**. Relaxed under certain demonstrations of responsible party, but in no case shall beneficial uses be impaired.
Where criteria & standards are applied:	At the boundary of the site or the nearest point of current use.	Any and all waters of the State, even **on-site** or **directly under the source** of contamination, due to the probability for future beneficial use.

combinations of constituents at the site, either on constituent mobility or on toxicologic endpoints (see Chapter 4 of this report).

The Designated Level Methodology is not designed to account for all potential impacts of a contaminated site (e.g., airborne migration of toxic constituents). Therefore other agencies, such as DHS and the Air Resources Board must be involved in site investigation and decision making processes. The Designated Level Methodology is intended to complement

Figure 15

SOLUBLE DESIGNATED LEVEL FOR A CONSTITUENT OF SOIL AT A CONTAMINATED SITE



the procedures of these and other agencies to assure the protection of human and environmental health and water quality. Where one agency's cleanup levels differ from those of another for the same site, the more restrictive levels will protect both agencies concerns and it is these levels that should guide the site mitigation effort. It is, therefore, imperative that all agencies with potential concerns be brought into the decision making process as early as possible.

NOTES AND REFERENCES

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[2] California State Water Resources Control Board. Title 23 of the California Administrative Code, Chapter 3, Subchapter 15, "Discharges of Waste to Land" (adopted 27 November 1984).

[3] California Department of Health Services. "Final Statement of Reasons for Proposed Regulations: Criteria for Identification of Hazardous and Extremely Hazardous Wastes" (adopted 22 February 1984).

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Appendix I

CALIFORNIA WASTE EXTRACTION TEST (WET)

Title 22 of the California Code of Regulations,
Division 4, Chapter 30, §66700.

California Register 85, No. 2
12 January 1985

NOTE: The underlined phrase below should be ignored if WET results are to be compared with Soluble Designated Levels or water quality based cleanup criteria.

66700. Waste Extraction Test (WET).

(a) The WET described in this section shall be used to determine the amount of extractable substance in a waste or other material as set forth in Section 66699(a).

(b) Except as provided in Section 66700(d), the WET shall be carried out if the total concentration in the waste, or other material, of any substance listed in Section 66699 equals or exceeds the STLC value, but does not exceed the TTLC value, given for that substance. The total concentrations of substances listed in Section 66699 shall be determined by analysis of samples of wastes, or other materials, which have been prepared, or meet the conditions, for analysis as set forth in subsections (c) and (d) of this section. Methods used for analysis for total concentrations of substances listed in Section 66699 shall be those given in the following documents or alternate methods that have been approved by the Department pursuant to Section 66310(e):

(1) For metal elements and their compounds, the waste shall be digested according to the indicated methods described in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", SW-846, 2nd edition, U.S. Environmental Protection Agency, 1982:

(A) All listed metal elements and their compounds, except hexavalent chromium: Method 3050.

(B) Hexavalent chromium: Method 3060.

(2) For the following substances, the indicated methods as described in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", SW-846, 2nd edition, U.S. Environmental Protection Agency, 1982 shall be utilized:

(A) Antimony: Method 7040 or Method 7041.

(B) Arsenic: Method 7060 or Method 7061.

(C) Barium: Method 7080 or Method 7081.

(D) Cadmium: Method 7131.

(E) Total chromium: Method 7190.

(F) Hexavalent chromium: Method 7195, Method 7196 or Method 7197.

(G) Lead: Method 7421.

(H) Mercury: Method 7470 or Method 7471.

(I) Nickel: Method 7520 or Method 7521.

(J) Selenium: Method 7740 or Method 7741.

(K) Silver: Method 7760 or Method 7761.

(L) Trichloroethylene: Method 8010 or Method 8240.

(M) Pentachlorophenol: Method 8040, Method 8250 or Method 8270.

(N) Aldrin, Lindane, Chlordane, DDD, DDE, DDT, Dieldrin, Heptachlor, Toxaphene and PCBS: Method 8080, Method 8250 or Method 8270.

(O) 2,4-Dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxypropionic acid: Method 8150.

(3) For the following substances, the indicated methods as described in "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020, U.S. Environmental Protection Agency, 1979 shall be utilized:

(A) Beryllium: Method 210.1 or Method 210.2.

(B) Cobalt: Method 219.1 or Method 219.2.

(C) Copper: Method 220.1 or Method 220.2.

(D) Molybdenum: Method 246.1 or Method 246.2.

(E) Thallium: Method 279.1 or Method 279.2.

(F) Vanadium: Method 286.1 or Method 286.2.

(G) Zinc: Method 289.1 or Method 289.2.

(H) Fluoride: Method 340.1, Method 340.2 or Method 340.3.

(4) For the following substances, the indicated methods as described in "Manual of Analytical Methods for the Analysis of Pesticides in Humans and Environmental Samples", EPA-600/8-80-038, U.S. Environmental Protection Agency, 1980 shall be utilized:

(A) Kepone: Section 5,A,(5),(a).

(B) 2,3,7,8-Tetrachlorodibenzo-p-dioxin: Section 9,G.

(5) For asbestos, the indicated method as described in the Federal Register, Volume 47, Number 103, Appendix A, pages 23376–23389, May 7, 1982 shall be utilized.

(c) Samples shall be prepared for analysis for total and extractable content of substances listed in Section 66699 (b) and (c) as follows:

(1) Type i: If the waste or other material is a millable solid, the sample shall be passed directly, or shall be milled to pass, through a No. 10 (two millimeter) standard sieve before it is analyzed. If the sample contains non-friable solid particles which do not pass directly through a No. 10 sieve and which are extraneous and irrelevant as hazardous constituents to the waste or other material, they shall be removed to the extent feasible by mechanical means and discarded. Solids which remain in the waste or other material after removal of the aforesaid extraneous particles shall be milled to pass through a No. 10 sieve and shall then be combined and mixed well with the solids which passed through the sieve without milling. The reconstituted sample shall then be analyzed as prescribed in this section.

(2) Type ii: If the waste or other material is a filterable mixture of liquid and solids in which the solids constitute five-tenths (0.5) percent by weight or greater of the sample, the liquid and solids shall be separated by filtration through a 0.45 micron membrane filter. The filtrate so obtained is to be designated as Initial Filtrate. Its volume is determined, and it is retained. The separated solids shall be sieved in a No. 10 sieve and any nonfriable extraneous particles of the kinds described in subsection (c) (1) which do not pass through the sieve shall be removed to the extent feasible by mechanical means and discarded. The solids which remain after removal of the extraneous particles shall be milled to pass through a No. 10 sieve and shall be recombined with solids which passed through the sieve without milling. This recombined solid material shall be extracted following the procedure in subsection (f). A ratio of 10 milliliters of extraction solution per gram of solid shall be utilized with appropriate modifications for extraction vessel size. After completion of solids extraction, the filtered extractant is combined with Initial Filtrate mixed thoroughly and anlyzed as described in subsection (f) (3).

(3) Type iii: If the waste or other material is a nonfilterable and nonmillable sludge, slurry, or oily, tarry or resinous material, it shall be analyzed as received unless it contains non-friable extraneous and irrelevant solid particles of the kinds described in paragraph (c) (1) of this section. If it contains such solid particles and they are of such size as not to pass through a No. 10 sieve, they shall be removed to the extent feasible by mechanical means and discarded. The remainder of the sample shall be analyzed as prescribed in this section.

(4) If it is necessary to dry a solid sample or the solids fraction of a sample before sieving, milling or removal of extraneous solids, or if a sample is dried prior to analysis, all weight losses due to drying shall be determined, and these losses and the conditions of drying shall be reported.

(d) If the waste or other material is a liquid containing less than five-tenths (0.5) percent by weight of undissolved solids, it shall not be subject to the WET procedure, but shall be analyzed directly for the substances listed in Section 66699. The waste shall be classified as a hazardous waste if the total concentration in the waste of any substances listed in Section 66699 exceeds the TTLC value given for that substance. If, however, the total concentration is less than the TTLC but exceeds the STLC when expressed on a milligrams per liter basis, the waste or other material shall be filtered through a 0.45 micron membrane filter, the solids discarded and the filtrate shall be analyzed directly for the substances listed in Section 66699. The waste shall be classifed as a hazardous waste if the concentration in the filtrate of any of the substances listed in Section 66699 exceeds the STLC value given for that substance.

(e) The WET extraction solution shall consist of 0.2 M sodium citrate at pH 5.0 ± 0.1, which is prepared by titrating an appropriate amount of analytical grade citric acid in deionized water with 4.0 N NaOH, except that the extraction solution for the determination of chromium (VI) shall consist of deionized water.

(f) The extraction procedure shall be as follows:

(1) Fifty grams of sample, or less if it is a type ii sample prepared pursuant to subsection (c) (2), obtained pursuant to subsection (c) or (d) of this section shall be placed in a clean polyethylene or glass container designated the Treatment, capable of physically withstanding the extraction procedure and which was rinsed previously with, in succession, an aqueous 1:1 ratio by volume nitric acid solution and deionized water. If the extract will be analyzed for any of the organic substances listed in Section 66699(c), a glass container shall be used. Furthermore, a container of the same size, shape and material shall be used for an extraction designated as the Blank, which shall be carried through the same procedure as the Treatment, but without addition of the sample.

(2) Five hundred milliliters of extraction solution, or less if the waste sample is a type ii sample prepared pursuant to subsection (c) (2) shall be added to the Treatment and Blank containers, which shall be then fitted with covered air scrubbers extended well into the extraction solutions and flushed vigorously with nitrogen gas for 15 minutes so as to remove and exclude atmospheric oxygen from the extraction medium. If the sample is to be analyzed for any volatile substance, such as trichloroethylene, the sample shall be added after deaeration with nitrogen to avoid volatilization loss. After deaeration the containers shall be quickly sealed with tightly fitting caps and agitated, using a table shaker, an overhead stirrer or a rotary extractor, operated at a speed which shall maintain the sample in a state of vigorously agitated suspension. Required equipment is described in test method 1310 in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", SW-846, 2nd edition, U.S. Environmental Protection Agency, 1982. The temperature during the extraction shall be maintained between 20 and 40 degrees centigrade. After 48 hours of extracting, the contents of the Treatment and Blank containers shall be either filtered directly or centrifuged and then filtered. Filtering shall be through a medium porosity prefilter and then through a 0.45 micron membrane filter, using a clean, thick-walled suction flask. For coarser solids, prefiltration shall not be necessary. Pressure filtration shall be an optional alternative to vacuum filtration. If the extracts are first centrifuged, glass or polyethylene bottles shall be used as prescribed for extraction. For very fine solids, centrifuging at as high as 10,000 × G may be necessary. After centrifugation, the liquids shall be decanted, prefiltered if necessary, and then passed through a 0.45 micron membrane filter. All filters shall be of low and identified extractable heavy metals, fluoride and organic chemicals content.

(3) If the filtered extracts are to be analyzed only for the metal elements listed in Section 66699(b), the filtered extracts from the Treatment and Blank shall be transferred to clean polyethylene bottles and acidified with nitric acid to five percent by volume acid content soon after each extract is filtered. For those wastes or waste materials classified under subsection (c) (2), the Treatment shall be the Initial Filtrate combined with the extract generated by the WET extraction of the initially separated solids. Similarly the Blank in this instance shall be the filtrate generated by the WET Blank accompanying the initially separated solids, to which is subsequently added a volume of deionized

water equivalent to that of the Initial Filtrate. These procedures shall be followed prior to acidification of Treatment and Blank solutions with nitric acid to five percent (by volume) acid content. The bottle shall then be stored at room temperature or frozen. If the extracts are also to be analyzed for the organic substances listed in Section 66699(c), or for the organic substances only, the filtered extracts shall be transferred to clean glass bottles. If the extracts are to be analyzed for fluoride, they shall be transferred to clean polyethylene bottles. These extracts, containing organic substances or fluoride, shall not be acidified, but shall be frozen soon after each extract is obtained and held frozen until the day of analysis, unless the extracts are analyzed within 24 hours.

(g) Sample analysis and data treatment shall be as follows:

(1) Each of the filtered extracts from the Treatment and Blank extractions shall have been acidified to five percent by volume nitric acid, and stored at room temperature or frozen in polyethylene bottles or kept frozen without addition of acid in glass bottles until the day of analysis, as prescribed. Each of the extracts shall be thoroughly mixed just prior to being individually analyzed for the substances listed in Section 66699 in order to determine whether the extractable concentration (EC) in the waste or other material exceeds the STLC for any of the substances listed. The extracts shall be analyzed according to the procedures identified in Sections 66700(b)(2), (b)(3) and (b)(4).

(2) The net EC of a substance in the Treatment sample which is listed in Section 66699 shall be calculated and reported as milligrams per liter of sample (mg/l). This value is derived after subtracting the concentration of the substance in the appropriate Blank extract from that concentration determined in the Treatment extract.

NOTE: Authority cited: Sections 208, 25141 and 25150, Health and Safety Code. Reference: Section 25141, Health and Safety Code.

HISTORY:

1. Editorial correction filed 10-5-84; designated effective 10-27-84 (Register 84, No. 41).

Appendix II

ACID-BASE ACCOUNT

Selected sections from:

Field and Laboratory Methods Applicable
to Overburdens and Minesoils

by Andrew A. Sobek, *et al*, West Virginia University

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with the U. S. Environmental Protection Agency.

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FIELD AND LABORATORY METHODS APPLICABLE TO OVERBURDENS AND MINESOILS

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1.3 PREPLANNING TOTAL MINING OPERATION

1.3.1 Acid-Base Account

In the humid areas of the United States, the toxicity associated with acid results largely from the oxidation of iron disulfides. This process takes place when earth disturbance activities such as mining (Temple and Koehler, 1954; Hill, 1970) and highway construction (Miller et al., 1976) expose iron disulfides to the atmosphere. Since the public in the United States has supported legislation that acid-toxic or potentially toxic materials (a source of pollution) will not be left exposed, the need for a basis to evaluate overburden materials arose.

Acid-base accounting is a dependable criterion by which overburden materials can be evaluated. An acid-base account consists of two measurements: (1) total or pyritic sulfur and (2) neutralization potential. The accounting balances maximum potential acidity (from immediately titratable sources plus sulfuric acid equivalent calculated from total sulfur) against total neutralizers (from alkaline carbonates, exchangeable bases, weatherable silicates or other rock sources capable of neutralizing strong acids as measured by the neutralization potentials).

The total or pyritic sulfur content (see 3.2.4) accurately quantifies potential acidity of materials when all sulfur is present as a pyritic mineral. When gypsum is found in an overburden sample or the materials are weathered, sulfur occurs in the form of sulfates. Samples high in organic carbon usually contain organic sulfur. When part of the sulfur occurs in nonacid-producing forms, the maximum potential acidity as calculated will be too high. It is for this reason that such calculations are referred to as maximums and that in doubtful cases appropriate acid and water leachings should be made to rule out those forms of sulfur which do not produce acid (see 3.2.6). Then from the stoichiometric equation of pyrite oxidation, the maximum potential acidity can be calculated in terms of calcium carbonate equivalent. Overburden material containing 0.1% sulfur (all as pyrite) yields an amount of sulfuric acid that requires 3.125 tons of calcium carbonate to neutralize one thousand tons of the material. The neutralization potential (see 3.2.3) of overburden materials, the second component of a net acid-base account, measures the amount of neutralizers present in the overburden materials. This measurement is found by treating a sample with a known amount of standardized hydrochloric acid, heating to assure complete reaction, and titrating with a standardized base. The result is then expressed in calcium carbonate equivalents. When balanced against acidity from the total sulfur measurement, a net acid-base account can be made.

From the acid-base account, potentially toxic material is defined as any rock or earth material having a net potential deficiency of 5.0 tons of calcium carbonate equivalent or more per 1000 tons of material. The 1000 tons is based on the assumption that an acre plow-layer contains 2 million pounds of soil. Regardless of the acid-base account, materials which have a pH of less than 4.0 in a pulverized rock slurry in distilled water are defined as being acid-toxic.

The choice of the deficiency of 5 tons of calcium carbonate equivalent per 1000 tons of material as the division between toxic and non-toxic material obviously is arbitrary. However, when applied to the large number of samples studied during the past several years of minesoil research at West Virginia University, it corresponds to other supporting laboratory information about these samples as well as to extensive field experiences with minesoils developing in the different rock types. If rock or soil samples were defined to be toxic at much lower calcium carbonate equivalent deficiencies than 5 tons per 1000 tons, we would be declaring many of our native soils to be toxic. On the other hand, with deficiencies much greater than 5 tons per 1000 tons, toxic concentrations of plant-available aluminum and pH values below 4.0 often develop rapidly.

Rock type is incorporated with the acid-base account because it is useful to categorize the materials which comprise coal overburdens. Knowledge of the rock types can provide an estimate of the texture and base status of a future minesoil, as well as stability of rock fragments. For example, sandstones containing moderate amounts of pyrite and lacking sufficient neutralizers become active acid producers when exposed to the atmosphere.

The properties previously discussed are represented graphically in Figure 1. There are two zones of acid-toxic materials (the 16.2 to 17.1 m and the 20.7 to 21.6 m depths) indicated by pH values of less than 4.0. Both zones contain enough sulfur to continue to overwhelm the small amount of neutralizers present. Thus, these materials have the potential for remaining acid-toxic unless large amounts of neutralizers (50 and 80 tons calcium carbonate equivalent per 1000 tons of material, respectively) are added. In addition, there is a zone of potentially toxic material at a depth of 13.4 to 16.2 m and two zones below the 23 m depth (underlying the first coal and overlying the bottom coal), which are defined by a calcium carbonate deficiency of more than 5 tons per 1000 tons of material even though the pH is above 4.0.

Non-toxic zones, which exhibit varying amounts of excess neutralizers, exist from the surface to a depth of 13.4 m, from the 17.1 to 21 m depth, and from the 24.4 to 25.4 m depth. These materials can be removed and replaced in sequential order, selectively blended before replacement, or totally blended before replacement. Other methods of handling the overburden materials would include utilization of the limestone, after crushing, as a source of neutralizers to be blended with the potentially toxic materials.

The acid-base accounting method provides a useful tool for evaluating overburdens in the humid areas of the United States, since it is useless to look for plant toxicities from elements such as aluminum, boron, etc., until the acid problem is eliminated.

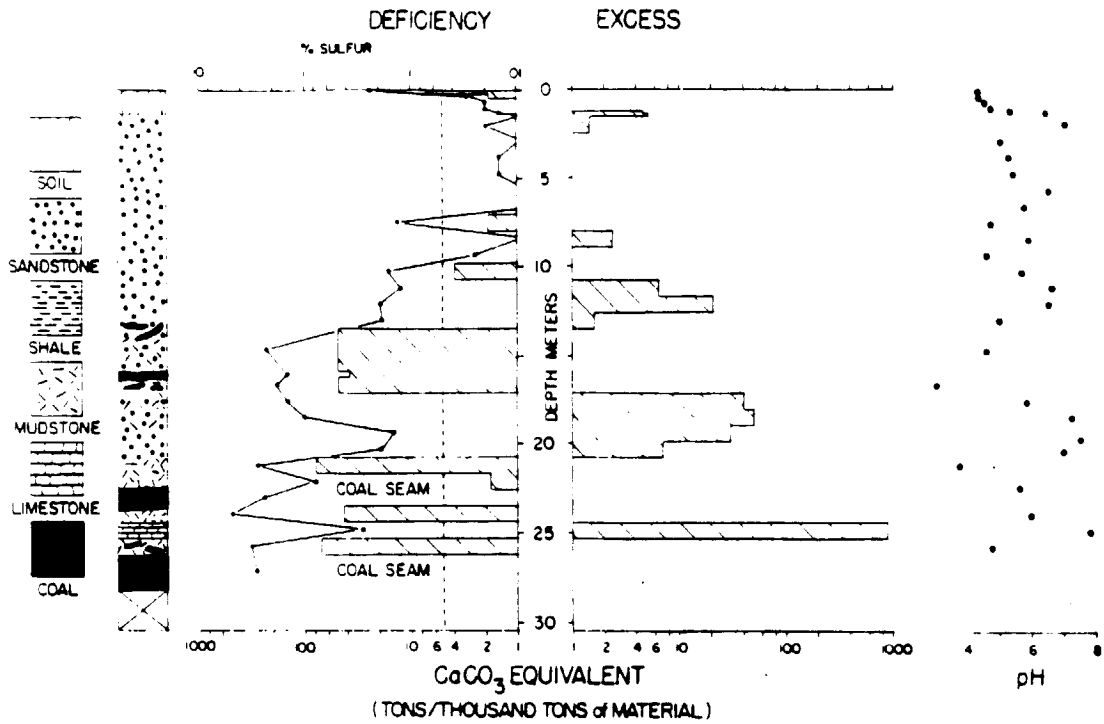

Figure 1. Acid-base account of the Kentucky no. 11 and no. 12 coal overburden.

10. Label vial with the sample identification shown on the field container.

11. Mix sample thoroughly by tumbling the vial end-over-end before subsampling for laboratory procedures (primarily chemical analyses).

3.2 CHEMICAL METHODS

3.2.1 Summary

Chemical methods for characterizing overburdens and minesoils are given. For a particular parameter, more than one method may be listed. This will allow the user of the manual some freedom of choice.

The determination of toxic or nontoxic materials due to acidity is overriding in importance in the Appalachian and Eastern and Western Interior Coal Provinces. The methods for determining toxic or potentially toxic materials are given high priority and are listed at the very front of the chapter. Methods 3.2.2, 3.2.3, 3.2.4, and 3.2.6 are used to determine the acid-base balance of minesoils and overburdens.

Next in importance is the nutrient status of the overburden materials. Nutrient status can be measured by using methods 3.2.5, 3.2.6, and 3.2.15. These methods give a measure of plant nutrients such as phosphorus, potassium, calcium, magnesium, and nitrogen. A knowledge of what plant nutrients are contained in an overburden material enables the mine operator to efficiently plan the mining operation so that full advantage can be taken of these nutrients in the resulting minesoil.

For more intensive study of minesoils and overburden materials, procedures for determining the cation exchange capacity (3.2.16 and 3.2.17) are given. Ways of estimating the lime requirement in minesols are presented in methods 3.2.7 through 3.2.10. Also, methods applicable to arid and semi-arid regions have been included.

3.2.2 Paste pH

3.2.2.1 Principle—

Perhaps the most commonly measured soil characteristic is pH. Soil pH was defined by Sorensen (1909) as the negative logarithm of the hydrogen-ion concentration. However, in actuality, hydrogen-ion activity is measured instead of hydrogen-ion concentration.

Soil pH is measured by a glass electrode incorporated with a pH meter for this procedure. Water is added to the sample forming a paste. The electrode is placed in the paste with pH being read directly from the meter.

3.2.2.2 Comments—

Six factors affecting the measurement of pH are: (1) drying the soil sample during preparation; (2) soil:water ratio used; (3) soluble salts content;

(4) seasonally influenced carbon dioxide content; (5) amount of grinding given the soil; and (6) electrode junction potential (Jackson, 1958; Peech, 1965).

Care must be taken to insure electrode life and accurate pH measurements: (1) Electrode should not remain in the sample longer than necessary for a reading, especially if more alkaline than pH 9.0. (2) Electrode should be washed with a jet of distilled water from a wash bottle after every measurement (sample or buffer solution). (3) Electrode should be dipped in dilute (1 part acid to 3 parts water) hydrochloric acid for a few seconds and washed with distilled water to remove any calcium carbonate film which may form, especially from alkaline samples. (4) Drying out of the electrode should be avoided. Electrode is cleaned and suspended in distilled water (which is protected from evaporation) for storage. (6) Place pH meter in standby position when electrode is not in a solution (Jackson, 1958; Peech, 1965).

The pH meter and electrode should be standardized with buffers differing by 3 or 4 pH units, such as 4.0 and 7.0, before beginning a series of measurements. After every tenth measurement, recheck the standardization with both buffers. Care should be taken not to contaminate one buffer with the other buffer or with the test solution. Never return used standard buffers to their stock bottles. The procedure describes the technique for measuring pH with a glass electrode and meter. If pH is taken in the field using color paper strips or indicator solutions, modification will have to be made by qualified personnel to the procedure.

3.2.2.3 Chemicals--

1. Standard buffer solutions, pH 4.00 and pH 7.00.

2. Distilled water (H_2O).

3.2.2.4 Materials--

1. pH meter (Corning model 12 or equivalent) equipped with combination electrode.

2. Paper cups, 30 ml (1 oz) capacity.

3. Plastic cups.

4. Stirring rod.

5. Wash bottle containing distilled water.

6. Balance, can be read to 0.1 g.

3.2.2.5 Procedure--

1. Turn on, adjust temperature setting, and "zero" pH meter per instruction manual.

2. Place pH 4.0 and pH 7.0 standard buffers in two plastic cups (one buffer in each cup). NOTE: NEVER return used buffers to stock bottles.

3. Place electrode in the pH 7.0 buffer.

4. Adjust pH meter to read pH 7.0.

5. Remove electrode from buffer solution and wash with a jet of distilled water from a wash bottle.

6. Place electrode in the pH 4.0 buffer and check the pH reading. NOTE: If pH meter varies more than ± 0.1 pH units from 4.0, something is wrong with the pH meter, electrode, or buffers.

7. Weigh 10 g of less than 60 mesh material into a paper cup.

8. Add 5 ml of distilled water to sample. NOTE: Do not stir! Allow water to wet sample by capillary action without stirring. With most overburden and minesoils materials, the 2:1 (soil:water) ratio provides a satisfactory paste for pH measurements; however, for the very coarse textured and the very fine textured material, more material or water can be added to bring the soil near saturation. At near saturation conditions, water should not be puddled nor dry soil appear at the surface.

9. Stir sample with a spatula until a thin paste is formed adding more water or soil as required to keep soil at saturation point. NOTE: At saturation, the soil paste glistens as it reflects light and the mixture slides off the spatula easily. Wash the spatula with a jet of distilled water before stirring another sample.

10. Place electrode in paste and move carefully about to insure removal of water film around the electrode. CAUTION: Do not trap particles between electrode and inside surface of the sample container. Electrodes are easily scratched. Contact between paste and electrode should be gentle to avoid both impact and scratching damage, especially in sandy samples.

11. When reading remains constant, record pH and remove electrode from paste. Carefully wash electrode with distilled water to insure removal of all paste. If all pH measurements are completed, the electrode should be stored in a beaker of distilled water. NOTE: After every 10 samples, check meter calibration with standard buffers.

3.2.3 Neutralization Potential

3.2.3.1 Principles--

The amount of neutralizing bases, including carbonates, present in overburden materials is found by treating a sample with a known excess of standardized hydrochloric acid. The sample and acid are heated to insure that the reaction between the acid and the neutralizers goes to completion.

The calcium carbonate equivalent of the sample is obtained by determining the amount of unconsumed acid by titration with standardized sodium hydroxide (Jackson, 1958).

3.2.3.2 Comments--

A fizz rating of the neutralization potential is made for each sample to insure the addition of sufficient acid to react all the calcium carbonate present.

During digestion, do not boil samples. If boiling occurs, discard sample and rerun. Before titrating with acid, fill buret with acid and drain completely. Before titrating with base, fill buret with base and drain completely to assure that free titrant is being added to the sample.

3.2.3.3 Chemicals--

1. Carbon dioxide-free water: Heat distilled water just to boiling in a beaker. Allow to cool slightly and pour into a container equipped with ascarite tube. Cool to room temperature before using.

2. Hydrochloric acid (HCl) solution, 0.1 N, certified grade (Fisher So-A-54 or equivalent).

3. Sodium hydroxide (NaOH), approximately 0.5 N: Dissolve 20.0 g of NaOH pellets in carbon dioxide-free water and dilute to 1 liter. Protect from CO_2 in the air with ascarite tube. Standardize solution by placing 50 ml of certified 0.1 N HCl in a beaker and titrating with the prepared 0.5 N NaOH until a pH of 7.00 is obtained. Calculate the Normality of the NaOH using the following equation:

$$N_2 = (N_1V_1)/V_2, \text{ where:}$$

V_1 = Volume of HCl used.

N_1 = Normality of HCl used.

V_2 = Volume of NaOH used.

N_2 = Calculated Normality of NaOH.

4. Sodium hydroxide (NaOH) approximately 0.1 N: Dilute 200 ml of 0.5 N NaOH with carbon dioxide-free water to a volume of 1 liter. Protect from CO_2 in air with ascarite tube. Standardize solution by placing 20 ml of certified 0.1 N HCl in a beaker and titrating with the prepared 0.1 N NaOH until a pH of 7.00 is obtained. Calculate the Normality of the NaOH using the equation in 3.2.3.3 No. 3.

5. Hydrochloric acid (HCl), approximately 0.5 N: Dilute 42 ml of concentrated HCl to a volume of 1 liter with distilled water. Standardize solution by placing 20 ml of the known Normality NaOH prepared in 3.2.3.3 No. 3 in a beaker and titrating with the prepared HCl until a pH of 7.00 is obtained.

Calculate the Normality of the HCl using the following equation:

$$N_1 = (N_2V_2)/V_1, \text{ where:}$$

V_2 = Volume of NaOH used.

N_2 = Normality of NaOH used.

V_1 = Volume of HCl used.

N_1 = Calculated Normality of HCl.

6. Hydrochloric acid (HCl), approximately 0.1 N: Dilute 200 ml of 0.5 N HCl to a volume of 1 liter with distilled water. Standardize solution as in 3.2.3.3.5, but use 20 ml of the known Normality NaOH prepared in 3.2.3.3 No. 4.

7. Hydrochloric acid (HCl), 1 part acid to 3 parts water: Dilute 250 ml of concentrated HCl with 750 ml of distilled water.

3.2.3.4 Materials—

1. Flasks, Erlenmeyer, 250 ml.

2. Buret, 100 ml (one required for each acid and one for each base).

3. Hotplate, steam bath can be substituted.

4. pH meter (Corning Model 12 or equivalent) equipped with combination electrode.

5. Balance, can be read to 0.01 g.

3.2.3.5 Procedure (revised and updated from Smith et al., 1974)--

1. Place approximately 0.5 g of sample (less than 60 mesh) on a piece of aluminum foil.

2. Add one or two drops of 1:3 HCl to the sample. The presence of $CaCO_3$ is indicated by a bubbling or audible "fizz."

3. Rate the bubbling or "fizz" in step 2 as indicated in Table 1.

4. Weigh 2.00 g of sample (less than 60 mesh) into a 250 ml Erlenmeyer flask.

5. Carefully add HCl indicated by Table 1 into the flask containing sample.

6. Heat nearly to boiling, swirling flask every 5 minutes, until reaction is complete. NOTE: Reaction is complete when no gas evolution is visible and particles settle evenly over the bottom of the flask.

TABLE 1. VOLUME AND NORMALITY OF HYDROCHLORIC ACID USED FOR EACH FIZZ RATING

Fizz Rating	HCl (ml)	HCl (Normality)
None	20	0.1
Slight	40	0.1
Moderate	40	0.5
Strong	80	0.5

7. Add distilled water to make a total volume of 125 ml.

8. Boil contents of flask for one minute and cool to slightly above room temperature. Cover tightly and cool to room temperature. CAUTION: Do not place rubber stopper in hot flask as it may implode upon cooling.

9. Titrate using 0.1 N NaOH or 0.5 N NaOH (concentration exactly known), to pH 7.0 using an electrometric pH meter and buret. The concentration of NaOH used in the titration should correspond to the concentration of the HCl used in step 5. NOTE: Titrate with NaOH until a constant reading of pH 7.0 remains for at least 30 seconds.

10. If less than 3 ml of the NaOH is required to obtain a pH of 7.0, it is likely that the HCl added was not sufficient to neutralize all of the base present in the 2.00 g sample. A duplicate sample should be run using the next higher volume or concentration of acid as indicated in Table 1.

11. Run a blank for each volume or normality of acid using steps 5,7, 8, and 9.

3.2.3.6 Calculations--

1. Constant (C) = (ml acid in blank)/(ml base in blank).

2. ml acid consumed = (ml acid added) - (ml base added X C).

3. Tons $CaCO_3$ equivalent/thousand tons of material = (ml of acid consumed) X (25.0) X (N of acid).

3.2.4 Maximum Potential Acidity by Total Sulfur Determination

3.2.4.1 Principles--

This method measures the total sulfur in a sample. If all of the total sulfur occurs in pyritic forms, the calculation of maximum potential acidity from sulfur corresponds with actual potential acidity from sulfur. But if part of the sulfur occurs in other forms, the maximum as calculated will be too high. This is the reason that such calculations are referred to as maximums and in doubtful cases approximate determinations should be made which rule out other sulfur forms (see 3.2.6). These determinations are not necessary when the maximum acid from total sulfur is within safe limits.

A sample is heated to approximately 1600°C. A stream of oxygen is passed through the sample during the heating period. Sulfur dioxide is released from the sample and collected in a dilute hydrochloric acid solution containing potassium iodide, starch, and a small amount of potassium iodate. This solution is automatically titrated with a standard potassium iodate solution.

A trace amount of potassium iodate reacts with potassium iodide and dilute hydrochloric acid to yield free iodine, potassium chloride and water. The free iodine combines with the sulfur dioxide and water to yield sulfuric acid and hydroiodic acid. The amount of potassium iodate solution used during the titration is recorded. The calculation of the percent total sulfur is based on the potassium iodate measurement (Smith et al., 1974).

3.2.4.2 Comments--

Some samples, e.g. coal, when first placed in the furnace may change the color of the solution in the titration vessel to pink or purple (probably due to organic compounds). Some samples may contain halogens (iodine, chlorine, fluorine) which darken the solution in the titration vessel and will therefore produce results that are low. The halogen problem, if encountered, may be eliminated by the use of an antimony trap between the furnace and titration assembly. Interference may result with samples high in nitrogen; however, this does not appear to happen with rock samples. Additional information can be obtained by reading Leco Equipment Application 120 and Instructions for Analysis of Sulfur in Hydrocarbons by the Leco High Frequency Combustion Titration Procedure.

Materials with a low chroma (2 or less) may have a high (over 1.0%) sulfur content; therefore, use a 0.250 g sample when the chroma of the material is 1 or 2. If the chroma of the material is zero, a 0.100 g sample is used. If sulfur is not detectable or more accurate values are desired in this sample size, increase to next highest sample size and rerun.

Read entire manuals on both the Leco Induction Furnace and the Automatic Titrator.

Periodically clean titration chamber and associated glassware with acetone or concentrated hydrochloric acid and rinse thoroughly with distilled water.

The following procedure is for use with a LECO Induction Furnace, Model 521 with Automatic Sulfur Titrator, Model 532. Other similar or advanced models of this instrumentation may perform equally well; however, the following procedure will require detailed modifications by a qualified person for application to other instruments.

3.2.4.3 Chemicals--

1. Iron chip accelerator (Leco number 501-077).

2. Iron powder accelerator (Leco number 501-078).

3. Copper ring (Leco number 550-189).

4. Magnesium oxide (MgO).

5. Potassium iodate (KIO_3), 0.0052 N: Dissolve 1.110 g KIO_3 in distilled water and dilute to 1 liter.

6. Hydrochloric acid (HCl) solution: Dilute 15 ml of concentrated HCl to a volume of 1 liter with distilled water.

7. Arrowroot starch solution: Dissolve 4.0 g of arrowroot starch (Leco number 501-061) in 100 ml of distilled water in a 250 ml beaker. Stir on a mechanical stirrer with a stirring bar. While starch is stirring, boil 300 ml of distilled and deionized water in a 600 ml beaker. Remove from heat when boiling point is reached. Remove starch from stirrer. Place boiled water on mechanical stirrer with stirring bar. While water is continually stirring, add 5 ml of starch mixture in 20 second intervals until all starch solution has been added. Place a small amount of the solution in the 600 ml beaker back into the 250 ml beaker that contained the starch mixture. Wash beaker by hard swirling and then pour contents back into the 600 ml beaker. Continue stirring solution in the 600 ml beaker allowing solution to cool to 40°C. Add 12.0 g of potassium iodide (KI). Continue stirring for 15 to 20 minutes.

8. Potassium iodide (KI).

9. Sulfur standards (Leco number 501-502).

3.2.4.4 Materials--

1. Leco Automatic Sulfur Analyzer, package unit, number 634-700.

2. Scoops, 0.2 ml volume.

3. Ceramic crucibles with porous covers.

4. Carboys, 19 liters (5 gal).

5. Tongs.

6. Glass wool.

7. Oxygen regulators.

8. Mechanical stirrer.

9. Stirring bar.

10. Combustion tube, hydrocarbon (Leco number 519-004).

11. Hot plate.

12. Balance, can be read to 0.001 g.

3.2.4.5 Procedure (revised and updated from Smith et al., 1974)--

NOTE: Read entire manuals on Leco Furnace, Automatic Titrator and this entire procedure before starting.

1. Place one level scoop of iron chips in crucible.

2. Weigh 0.500 g of sample (less than 60 mesh) into the crucible.

NOTE: For samples that are suspected to contain over 1% sulfur or have a chroma of less than 2, see 3.2.4.2.

3. Add one scoop MgO.

4. Add one copper ring and then one scoop of iron powder.

5. Gently shake the crucible to evenly cover the bottom and place one porous cover on the crucible.

6. Turn on "Filament Voltage" grid tap to medium position.

7. Wait for one minute then turn "High Voltage" switch to ON.

8. Set "Titrate-Endpoint" switch to its middle position.

9. Turn on titrator (upper left switch above "Endpoint Adjust").

10. Drain "Titration Vessel" completely.

11. Set timer switch to ON, adjust timer to 10 minutes, or a time sufficient to satisfy steps 25, 26, and 27.

12. Slosh carboys containing HCl and KIO_3 to mix the condensate on the walls of the container.

13. Fill "Iodate Buret."

14. Fill "Titration Vessel" approximately one-third full with the HCl solution.

15. Turn on oxygen. Set the pressure to 15 psi, and the flow rate to 1.0 liter per minute. NOTE: Oxygen flow must be started before starch is added.

16. Raise the "Locking Mechanism Handle" WITHOUT a sample crucible on the pedestal, and lock in place. NOTE: Make sure there is an airtight contact between sample platform and combustion chamber by observing a vigorous bubbling in the "Titration Vessel" chamber.

17. Add one measure (5 ml) of starch solution. NOTE: If solution in "Titration Vessel" chamber turns turbid or yellow after starch solution is added, turn off the instrument following steps 33 through 39 and make NEW starch solution.

18. Set "Titrate-Endpoint" switch to "Endpoint."

19. After a few seconds when titrant level in "Iodate Buret" has stopped falling (Buret reading should be no more than 0.004) the solution in the "Titration Vessel" chamber should be a deep blue. NOTE: If the solution is a pale blue or almost black, turn off the instrument following steps 33 through 39 and make NEW starch solution.

20. Set "Titrate-Endpoint" switch to middle position and lower "Locking Mechanism Handle."

21. Refill "Iodate Buret."

22. Place sample crucible on pedestal, making sure it is centered, and carefully raise "Locking Mechanism Handle" and lock in place.

NOTE: Make sure there is an airtight contact between sample platform and combustion chamber by observing a vigorous bubbling in the "Titration Vessel" chamber.

23. Set "Titrate-Endpoint" switch to Titrate, or if it is known that sample will evolve SO_2 slowly, set switch at Endpoint. The Endpoint setting acts as a "Fine Control" allowing buret valve to discriminate smaller increments.

24. Push RED button on timer to start analysis.

25. Plate current must go to 400-450 ma for at least 2 minutes during the analysis; if not, reweigh and rerun sample.

26. Adjust rheostat to prevent plate current from exceeding 450 ma.

27. When buret reading does not change for 2 minutes, and Plate Current has achieved 400 to 450 ma, it can be assumed that all of the sulfur has been removed from the sample. If buret reading is still changing when timer shuts off instrument, set Timer Switch to OFF, which restarts furnace, leave furnace on until buret is stable for 2 minutes, then turn Timer Switch to ON.

28. Set "Titrate-Endpoint" to middle position. IMPORTANT: Record titration reading.

29. Lower sample platform, remove crucible using tongs, place fresh sample crucible in place, but do not close sample chamber.

NOTE: Slightly drain titrating chamber to maintain original level. Drain, flush, and refill titrating chamber every 3rd sample, or more often if a large quantity of titrant was used by the previous sample (steps 16-22).

30. Refill KIO_3 buret.

31. Close sample chamber, making sure it is tight. Check endpoint (steps 18, 19 and 21).

32. Go to step 23 and continue until all samples have been processed.

33. Turn "Titrate-Endpoint" switch to mid position.

34. Turn off main O_2 valve on top of tank.

35. Turn off "High Voltage."

36. Turn off Automatic Titrator.

37. Drain titration chamber; flush twice with a chamber full of HCl solution or water, cover and leave chamber full of HCl solution.

38. If O_2 has stopped bubbling in the purifying train, turn off small knurled valve on gauge outlet.

39. Turn off "Filament Voltage."

3.2.4.6 Calculations—

1. Percent sulfur. NOTE: Percent sulfur is dependent upon the concentration of potassium iodate titrant and sample size.

A. Using 1.110 g KIO_3/L and 0.500 g sample (0.005 - 1.00% sulfur range)
%S = Buret reading X 5.0.

B. Using 1.110 g KIO_3/L and 0.250 g sample (0.010 - 2.00% sulfur range)
%S = Buret reading X 10.0.

C. Using 1.110 g KIO_3/L and 0.100 g sample (0.025 - 5.00% sulfur range)
%S = Buret reading X 25.0.

2. To convert % sulfur to maximum $CaCO_3$ equivalents: Multiply % sulfur by 31.25 to get tons $CaCO_3$ equivalent/1000 tons of material.

3.2.6.1 Principle--

In doubtful cases, as stated in 3.2.4.1, this method should be used to rule out HCl-extractable and non-extractable forms of sulfur which are not considered to be acid formers. The HNO_3-extractable sulfur is determined by calculations. This form of sulfur will react with oxygen to produce acid.

3.2.6.2 Comments--

It is necessary to remove chlorides and nitrates by water leachings after the hydrochloric and nitric acid (respectively) extractions before running total sulfur.

Care should be taken that no sample is lost by run over, splashing or breaking through the filter paper during all leachings.

3.2.6.3 Chemicals--

1. Hydrochloric acid (HCl), 2 parts acid to 3 parts water: Mix 400 ml of concentrated HCl with 600 ml of distilled water.

2. Nitric acid (HNO_3), 1 part acid to 7 parts water: Mix 125 ml of concentrated HNO_3 with 875 ml of distilled water.

3. Silver Nitrate ($AgNO_3$), 10%: Dissolve 10.0 g of $AgNO_3$ in 90 ml of distilled water. Store in amber bottle away from light.

4. Nessler's Solution (Fisher Scientific Co. No. So-N-24 or equivalent).

3.2.6.4 Materials--

1. Leco Induction Furnace and Automatic Sulfur Titrator as in 3.2.4.4.

2. Funnels, 28 mm I.D. polyethylene.

3. Filter paper, 5.5 cm glass fiber.

4. Flasks, Erlenmeyer, 250 ml.

5. Beakers, 100 ml.

6. Syringe.

7. Balance, can be read to 0.001 g.

3.2.6.5 Procedure (Revised and updated from Smith et al., 1974)—

1. Take three 0.500 g subsamples of less than 60 mesh material.

2. Take one subsample and analyze for total sulfur (see 3.2.4).

3. Taking care not to sharply crease the glass fibers, fold filter paper to fit a polyethylene funnel.

4. Place second subsample in filter. NOTE: Make sure all material is placed in the filter.

5. Place subsample and filter onto funnel holder in sink or other suitable pan which can receive outflow from funnel.

6. Using a syringe, pipette, or other graduated dispenser, add 2:3 HCl to almost the top of the filter paper. Caution: During this step and all other leaching steps, be careful not to lose any sample by runover, splashing, or breaking through the filter paper.

7. Repeat step 6 until a total of 50 ml of acid has been added.

8. Place funnel holder, containing funnel and subsample, over a 100 ml beaker.

9. Leach subsample with 50 ml of distilled and deionized water. Discard leachate. NOTE: Stop here if procedure cannot be completed in one day. CAUTION: Samples must be kept moist.

10. Leach subsample with another 50 ml of distilled and deionized water.

11. Test leachate for chlorides by adding 3 drops of 10% $AgNO_3$ with a dropper. NOTE: The presence of chlorides will be detected by a white precipitate.

12. Discard leachate and repeat steps 10 and 11 until no precipitate forms.

13. Discard leachate.

14. Air dry subsample and filter overnight.

15. Carefully fold glass fiber filter around the sample and transfer to a ceramic crucible for total sulfur analysis (see 3.2.4).

16. Place third subsample in a 250 ml Erlenmeyer flask. NOTE: Make sure all of the subsample is placed in the flask.

17. Add 50 ml of HNO_3 (1:7).

18. Let stand overnight at room temperature.

19. Taking care not to sharply crease the glass fibers, fold a filter to fit a polyethylene funnel.

20. Place a funnel holder over a sink or other suitable pan which can receive outflow from funnel.

21. Carefully pour subsample and acid from the Erlenmeyer flask into the funnel. NOTE: Do not get material above top of filter paper.

22. Repeat step 21 using distilled and deionized water to wash all materials remaining in the Erlenmeyer flask into the funnel.

23. Place funnel holder containing funnel and subsample over a 100 ml beaker. NOTE: Stop here if procedure cannot be completed in one day. CAUTION: Sample must be kept moist.

24. Leach subsample with 50 ml of distilled and deionized water. Discard leachate.

25. Leach subsample with another 50 ml of distilled and deionized water.

26. Test leachate for presence of nitrates by adding 3 drops of Nessler's Solution with a dropper. NOTE: If nitrates are present, the leachate will turn yellow within 30 seconds as seen against a white background.

27. Discard leachate and repeat steps 25 and 26 until no nitrates are detected.

28. Discard leachate.

29. Air dry subsample and filter overnight.

30. Carefully fold glass fiber filter around the sample and transfer to a ceramic crucible for total sulfur analysis (see 3.2.4).

3.2.6.6 Calculations--

1. HCl-extractable sulfur (mostly sulfates) = (Total sulfur of untreated sample) minus (Total sulfur after HCl treatment).

2. HNO_3-extractable sulfur (mostly pyritic sulfur) = (Total sulfur after HCl treatment) minus (Total sulfur after HNO_3 treatment).

3. Non-extractable sulfur (mostly organic sulfur) = Total sulfur after HNO_3 treatment.

Appendix III

A COMPILATION OF WATER QUALITY GOALS

From the Staff Report of the same name
by the California Regional Water Quality Control Board, Central Valley Region

May 1989
(plus July 1989 update)

CONTENTS:

Selecting Water Quality Goals

Cross Reference of Chemical Names

Inorganic Constituents

Organic Constituents

Footnotes

References

Note: *The Designated Level examples presented in earlier versions of Appendix III have been deleted due to misapplication by persons who did not have access to the text of this report. Designated Levels applicable to particular waste constituents and to a particular disposal situation or site may be calculated from the Water Quality Goals presented in this Appendix. The reader is referred to the text of "The Designated Level Methodology" for a discussion of the derivation and proper use of Designated Levels.*

Selecting Water Quality Goals

In most cases, background water quality — the concentrations of substances in natural waters which are unaffected by waste management practices or contamination incidents — are appropriate water quality goals. However, if it is determined that some water quality degradation is in the best interest of the State (see State Board Resolution 68–16, "Statement of Policy With Respect to Maintaining High Quality Waters in California" and other applicable State Board policies), water quality goals may be selected by identifying:

1) the bodies of water which could be affected by the particular waste management activity or contamination incident;

2) the present *and probable future* beneficial uses of waters which may be affected; and

3) numerical concentrations of contaminants or other parameters in the waters which will protect those beneficial uses.

The Water Quality Control Plan Reports ("Basin Plans") should always be consulted to determine beneficial uses. Also cited in the Basin Plans are "water quality objectives" for several constituents of concern which, among other things, are based on background water quality and, if not exceeded, should protect those uses and prevent nuisances. State Board policies for water quality control also impose certain water quality limitations. Where Basin Plan objectives are stated in general terms, such as "no toxic chemicals in toxic amounts", or where specific objectives for the contaminant or parameter of interest do not exist or if it appears that the objective is not protecting the beneficial use, Regional Board staff is encouraged to consult with staff specialists in the Standards, Policies and Special Studies and Environmental/ Technical Support Units for assistance. In these cases, water quality criteria from sources other than the Basin Plan may be used to protect beneficial uses.

Human Health

- Primary Drinking Water Standards or Maximum Contaminant Levels (MCLs) in Title 22 of CCR, Division 4, Chapter 15, "Domestic Water Quality and Monitoring" which have been adopted by DHS, often from the National Interim Primary Drinking Water Regulations, for use in California;

  Note: These values are derived in conjunction with technologic and economic factors and are, therefore, not purely health-based.

- State "Action Levels" published by the Sanitary Engineering Branch of DHS;

- Maximum Contaminant Level Goals (MCL Goals) promulgated by the U.S. EPA under the National Primary Drinking Water Regulations as the first step in establishing MCLs;

  Note: By law, these are purely health based values, and are set at "zero" for carcinogens.

- Proposition 65 No-Significant-Risk Levels (NSRLs) established by the Health and Welfare Agency in CCR Title 22 for known human carcinogens and reproductive toxins and the water quality criteria drafted by State Board which convert the NSRLs into concentrations in water;

- Quality Criteria for Water, 1986 (the "Gold Book") and the Ambient Water Quality Criteria volumes (1980, 1984, and 1987) published by EPA for the priority pollutants which contain No-Adverse-Effect Levels for non-carcinogens, 1-in-a-million incremental cancer risk estimates for carcinogens, and other toxicity-based criteria;

- Quality Criteria for Water (the "Red Book") published by EPA in 1976 [superseded by Quality Criteria for Water, 1986 (the "Gold Book") and the Ambient Water Quality Criteria volumes for the priority pollutants];

- Water Quality Criteria, 1972 (the "Blue Book") published by EPA in 1973 [superseded by Quality Criteria for Water (the "Red Book")];

- "Health Advisories" and "Water Quality Advisories" published by the U.S. EPA, Office of Drinking Water and Office of Water Regulations and Standards which include short and long term health advisories and 1-in-a-million incremental cancer risk estimates for carcinogens;

- Drinking Water and Health volumes 1, 3, 4, 5, 6, and 7 published by the National Academy of Sciences which include Suggested No-Adverse-Response Levels or SNARLs [values are presented for some carcinogens which do not include consideration of the cancer risk posed by those chemicals] and 1-in-a-million incremental cancer risk estimates;

- "Estimated Permissible Ambient Goals" published by EPA in 1977 as informal criteria;

  Note: These are estimated from occupational exposure to airborne pollutants and are, therefore, not very reliable. They should only be used if no other criteria are available.

Human Welfare

- Secondary MCLs (Drinking Water Standards) in Title 22 of CCR, Division 4, Chapter 15, "Domestic Water Quality and Monitoring" which have been adopted by DHS, often from the National Secondary Drinking Water Regulations, for use in California;

- State "Action Levels" published by the Sanitary Engineering Branch of DHS which contain taste and odor thresholds for some chemicals;

- Ambient Water Quality Criteria volumes published by EPA in 1980 for the priority pollutants which contain taste and odor-based criteria for some chemicals;

Aquatic Life and Wildlife

- Quality Criteria for Water, 1986 (the "Gold Book") and the Ambient Water Quality Criteria volumes for the priority pollutants (1980) published by EPA with updates for some chemicals published in 1985;

Note: 4-day average, 24-hour average, or chronic criteria should be used as water quality goals whenever available to protect the surface water resource for the long term.

- "Water Quality Advisories" published by the U.S. EPA, Office of Water Regulations and Standards;
- Quality Criteria for Water (the "Red Book") published by EPA in 1976;
- Water Quality Criteria, 1972 (the "Blue Book") published by EPA in 1973;
- The Department of Fish and Game and staff of our Standards, Policies and Special Studies unit may also supply criteria for fish and wildlife protection;

Agricultural Use

- Water Quality for Agriculture published by the Food and Agriculture Organization of the United Nations in 1985;

Other Uses

- Water Quality Criteria written by McKee and Wolf and published by the State Water Resources Control Board in 1963 which contains criteria for human health and welfare, aquatic life, agricultural use, industrial use, and various other uses.

To protect the maximum number of beneficial uses, the most restrictive (lowest), applicable, and justifiable water quality criteria should be selected. Due to the rapidly changing data base on the health and environmental effects of chemicals, caution should be observed in selecting among the various water quality criteria to be sure that the most recent information is utilized. The original literature should be consulted whenever possible to determine the applicability and limitations of the criteria being selected. Other government agencies, such as the California Department of Health Services, the California Department of Fish and Game, and the U.S. Environmental Protection Agency may be consulted for up-to-the-minute information.

It is common practice to rely on Primary MCLs as "enforceable water quality standards" for human health. However, care should be taken in the application of Primary MCLs to the protection of *sources* of drinking water. A common example of incorrect application is the use of the total trihalomethane (TTHM) MCL for the protection of ground water from chloroform. Chloroform is one of the four chemicals covered by the term "trihalomethanes". The TTHM standard of 100 µg/l is 18 to 526 times higher than the 1-in-a-million incremental cancer risk estimates for chloroform. EPA has stated that the MCL for TTHMs was based mainly on technology and economics. Therefore, this standard does not clearly protect the beneficial use for domestic supply of waters of the State. The MCL for TTHMs was derived, for application to drinking water as it is delivered to consumers after disinfection by chlorination, by balancing the benefit provided by the chlorination process (elimination of pathogens in drinking water) with the health threat posed by the trihalomethane by-products of this process. In the case of contaminated ground water this type of cost/benefit balancing is not germane, and so the MCL does not apply to the protection of the ambient quality of domestic water supply sources.

The 1-in-a-million cancer risk estimates of 0.19 to 5.6 μg/l should be used as the measure of potential impairment by chloroform of the beneficial use of ground water for domestic supply. Staff of EPA, Region 9 has stated that the application of the 1-in-a-million cancer risk estimate, instead of the TTHM MCL, as a water quality goal for chloroform in ground water appears to be consistent with the federal Clean Water Act and the Safe Drinking Water Act and that the TTHM standard is not appropriate for protection of ambient water quality.

In fact, virtually all primary MCLs are derived by balancing the technologic and economic concerns that are directly related to the use of water for domestic supply with the health effects information developed under the MCL Goal process. Thus primary MCLs are not necessarily reliable indicators of protection of beneficial uses of ambient waters and should not necessarily be relied upon as water quality goals in these situations. There are other instances where water quality criteria more stringent than MCLs are applied to protect the beneficial uses of a water resource. For example, it is common practice to require compliance with aquatic life criteria for heavy metal contaminants in surface waters that are often much lower than MCLs for the same contaminants.

Once it has been decided that some degradation in water quality will be permitted (i.e., background water quality is not used for water quality goals), other factors may require water quality goals to be set below water quality standards and criteria. Care should be taken to consider other dischargers in the area and the contribution to the degradation of water quality that each imposes. If one discharger is permitted through the disposal of his waste to degrade the water resource to just below the point where beneficial uses are impaired, then no additional capacity exists for further degradation by other discharges of waste. In addition, the knowledge of the health and environmental effects of chemicals or combinations of chemicals is constantly evolving. What is considered to be safe at or below 10 μg/l today may be found to be harmful at 1 μg/l tomorrow.

A Note About Water Quality Standards

Water Quality Standards are a unique application of water quality criteria and are defined in the regulations which implement the Clean Water Act. That definition reads:

> "Water quality standards are provisions of state or federal law which consist of a designated use or uses for the waters of the United States and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the Act."
>
> — 40 CFR 130.2(c) and 131.3(i)

In California, the Basin Plans and other water quality control plans, such as the Ocean Plan and the Delta Plan, contain the State's Water Quality Standards because these plans set forth beneficial uses and water quality objectives.

DISCLAIMER

This publication is a technical report by staff of the California Regional Water Quality Control Board, Central Valley Region.
No policy or regulation is either expressed or intended.

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OFFICE OF ENVIRONMENTAL PROTECTION
James M. Strock, Secretary

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Staff Report of the
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

A Compilation of

WATER QUALITY GOALS

September 1991

Selecting Water Quality Goals

Cross Reference of Chemical Names

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Organic Constituents

Footnotes

References

PREPARED BY: JON B. MARSHACK, D. ENV.

United States Environmental Protection Agency
Office of Water WH-550A
EPA 811-F-92-001
May 1992

EPA

Phase V Rule

F•A•C•T•S•H•E•E•T

The Safe Drinking Water Act (SDWA) amendments passed by Congress in 1986 require EPA to set drinking water standards for 83 contaminants listed in the Act, and an additional 25 contaminants every three years. To date, the Agency has promulgated National Primary Drinking Water Standards for eight volatile organic chemicals (VOCs), fluoride, coliform and other microbiological contaminants, 38 synthetic organic chemicals (SOCs) and inorganic chemicals (IOCs), and lead and copper. Regulations for Phase V, radionuclides (proposed July 1991), and a revised standard for arsenic (expected November 1992) count toward completion of the required 83.

The Phase V Rule sets drinking water standards for 23 contaminants that may be found in drinking water. The regulation includes Maximum Contaminant Levels (MCLs), Maximum Contaminant Level Goals (MCLGs), requirements for monitoring, reporting, public notification, and Best Available Technologies (BATs) for water treatment. In general, a low occurrence of these contaminants is expected in drinking water, and it is estimated that 256 systems will exceed an MCL, with most systems exceeding the MCL for antimony. Cost estimates include a monitoring cost of $5 million, state implementation cost of $10 million, and annual treatment cost of $31 million, for a total of $46 million. These regulations become effective 18 months after the promulgation date.

Table 1. MCLGs AND MCLs FOR INORGANIC AND ORGANIC CONTAMINANTS

Contaminant	MCLGs (mg/l)	MCLs (mg/l)
IOCs		
Antimony	0.006	0.006
Beryllium	0.004	0.004
Cyanide	0.2	0.2
Nickel	0.1	0.1
Sulfate	deferred	deferred
Thallium	0.0005	0.002
VOCs		
Dichloromethane	zero	0.005
1,2,4-Trichlorobenzene	0.07	0.07
1,1,2-Trichloroethane	0.003	0.005
Pesticides		
Dalapon	0.2	0.2
Dinoseb	0.007	0.007
Diquat	0.02	0.02
Endothall	0.1	0.1
Endrin	0.002	0.002
Glyphosate	0.7	0.7
Oxamyl (Vydate)	0.2	0.2
Picloram	0.5	0.5
Simazine	0.004	0.004
Other Organic Contaminants		
Benzo(a)pyrene	zero	0.0002
Di(2-ethylhexyl)adipate	0.4	0.4
Di(2-ethylhexyl)phthalate	zero	0.006
Hexachlorobenzene	zero	0.001
Hexachlorocyclopentadiene	0.05	0.05
2,3,7,8-TCDD (Dioxin)	zero	3×10^{-8}

DRINKING WATER STANDARDS

Maximum Contaminant Levels (MCLs): Public Water Systems are required to make sure that the water they supply does not exceed the MCL for each Phase V chemical. These are enforceable standards which are considered feasible and safe.

Maximum Contaminant Levels Goals (MCLGs): For each chemical, EPA has set a non-enforceable health goal which water systems should try to achieve. Water containing a chemical in an amount equal to or below its MCLG is not expected to cause any health problems, even over a lifetime of drinking this water. Final MCLs and MCLGs for Phase V chemicals are listed in Table 1.

APPLICABILITY OF MCLs

MCLs established under the Safe Drinking Water Act are Federally enforceable standards for finished water provided by Public Water Supply Systems. In addition, these standards are often used as reference points for the protection and remediation of water resources under several EPA programs as well as programs implemented by other federal agencies and states.

MONITORING REQUIREMENTS

Phase V makes use of the standard monitoring framework, which will reduce the complexity of the monitoring requirements, coordinate the requirements among various regulations, and synchronize the monitoring schedules, by establishing "three year" monitoring periods for drinking water contaminants.

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A previous drinking water regulation (Phase II, January, 1991) required that certain public water supplies monitor for specified unregulated contaminants by December 1995, including a number of Phase V contaminants. The final Phase V rule takes advantage of this requirement and uses the 1993-1995 initial monitoring date for all contaminants for water systems with 150 or more service connections. Smaller systems are required to monitor during the 1996-1998 monitoring period. States determine when, within the 3-year monitoring period, each water system is to monitor. Monitoring requirements are given below in Table 2.

Table 2. COMPLIANCE MONITORING REQUIREMENTS[1]

Contaminant	Basic Requirement		Trigger that Increases Monitoring	Waiver[2]
	Ground Water	Surface Water		
4 Inorganic	1 Sample per 3 Yr	Annual Sample	>MCL	YES Based on Analytical Results of 3 Rounds
	1 Sample/9 Years After 3 Samples <MCL			
Cyanide	1 Sample per 3 Yr	Annual Sample	>MCL	YES Based on vulnerability assessment
	1 Sample/9 Years After 3 Samples <MCL			
3 Volatile Organics	Quarterly/yr; Annual After One Year of No Detect; Every 3 Years After 3 Rounds		≥0.0005 mg/l	YES Based on vulnerability assessment
15 Pesticides/ Synthetic Organics	4 Quarterly Samples Every 3 yrs; After 1 Round of No Detect: Systems >3,300 Reduce to 2 Samples/Yr Every 3 Yrs, Systems ≤3,300 reduce to 1 sample Every 3 Yrs		Detection (as specified in the rule)	YES Based on vulnerability assessment

[1] The compliance monitoring requirements apply to community water systems and non-transient non-community water systems.

[2] Two types of waivers are available: waivers by rule and vulnerability waivers. Waivers by rule are based on prior monitoring results. They reduce but do not eliminate monitoring. Vulnerability waivers eliminate monitoring but must be renewed, usually every three years.

RELATED FEDERAL WATER QUALITY PROGRAMS

Many of the contaminants regulated under the SDWA are subject to regulation under other Federal environmental statutes. For example, MCLs established under the SDWA are often used as human health criteria established under the Clean Water Act. Pesticides (including 9 Phase V contaminants) are regulated under the Federal Insecticide, Fungicide, and Rodenticide Act. In addition, voluntary programs have been established by the U.S. Department of Agriculture and other Federal agencies (in cooperation with EPA) to reduce risks of contamination of surface water and ground water from pesticides and other substances.

FOR MORE INFORMATION

Call the Safe Drinking Water Hotline at: **1-800-426-4791**

MEMORANDUM

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD • CENTRAL VALLEY REGION
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TO: Technical Staff
Fresno, Redding,
and Sacramento Offices
and Interested Persons

FROM: Jon B. Marshack
Senior Environmental Specialist
Environmental/Technical Support

DATE: 18 September 1991

SIGNATURE:

SUBJECT: *SEPTEMBER 1991 EDITION OF "WATER QUALITY GOALS"*

This is the latest edition of the staff report *A Compilation of Water Quality Goals.* It supersedes the February 1991 edition. ***The February 1991 edition and all earlier editions should be discarded, as they contain outdated information.*** The new edition contains information assumed to be current as of 18 September 1991.

Significant changes have been incorporated into this edition of *Water Quality Goals.* Numerical water quality objectives from State Board's *Inland Surface Waters Plan* and *Enclosed Bays & Estuaries Plan* have been added. Revisions include newly promulgated drinking water MCLs and MCL Goals from the U. S. EPA, and new and revised health advisories and cancer risk estimates also from U. S. EPA. The Footnotes and References sections have been updated accordingly, and the remainder of the tables have been reformatted to accommodate the new information. Future changes to the contents of this report, which do not necessitate extensive reformatting, will be accomplished through the distribution of individual updated pages.

I strongly urge all users of the manual to read the narrative "Selecting Water Quality Goals", found at the beginning of the report, carefully before attempting to select criteria from the tables. An example of water quality goal selection is included in this narrative.

Copies of the September 1991 edition of *Water Quality Goals* are available to those outside of the Regional Board. Public agencies may receive copies free of charge, with the allowable number of copies per agency based on current supply. Private entities may receive the report for a cost of $10.00 per copy. Requests should be addressed to Jeannette Miller in the Sacramento Office, and should be prepaid if applicable (with the check made payable to the Regional Water Quality Control Board).

If you have questions regarding the *Water Quality Goals* staff report or this memorandum, please feel free to contact me at (916) 361-5724 or CALNET (ATSS) 8/495-5724.

JBM

cc: Regional Board Assistant Executive Officers
David Cohen, SWRCB, Division of Water Quality
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USING THIS MANUAL

This manual is divided into six sections:

- Selecting Water Quality Goals
- Cross Reference
- Water Quality Goals — Inorganic Constituents
- Water Quality Goals — Organic Constituents
- Footnotes
- References

Selecting Water Quality Goals describes the process by which numerical values for water quality parameters and constituents may be selected to protect beneficial uses of the ground and surface waters of California. ***To be able to correctly use this manual, the author strongly recommends that this section be carefully reviewed.***

The *Cross Reference* provides a list of the chemical constituents and parameters for which numerical limits are contained in the *Water Quality Goals* sections. Many chemical constituents are commonly referred to by more than one name. To find water quality goals listings for a particular constituent, first find its name in the *Cross Reference* section to determine the name for the constituent that is used in the remainder of this manual.

The next two sections contain numerical water quality goals for *Organic Constituents* (those chemicals whose chemistry is dominated by the chemistry of the carbon atom) and *Inorganic Constituents* (all other chemicals and parameters). These two sections are each divided into four subsections, which provide numerical values protective of:

- Human Health and Welfare —
  Inorganics page 1
  Organics pages 1 through 5
- Agricultural Use, Health & Welfare, and Freshwater Aquatic Life —
  Inorganics pages 2, 5, and 7 through 14
  Organics pages 6 through 10
- Health & Aquatic Life — Inland Surface Waters and Enclosed Bays & Estuaries —
  Inorganics pages 3
  Organics pages 11 through 15
- Marine Resources —
  Inorganics pages 4 and 6
  Organics pages 16 through 20

Many listings in these sections are followed by footnotes in parentheses. *Footnotes* are found on the second to the last page of the manual.

References for the numerical water quality goals are provided on the last page of the manual, divided by topics which correspond to column headings in the *Water Quality Goals* tables.

SELECTING WATER QUALITY GOALS

Improper waste management practices and sites at which pollutants have been inadvertently released pose significant threats to the quality of California's usable ground and surface water resources. The purpose of this paper is to outline California's system for assessment of pollutant impacts and potential impacts from waste management activities and other anthropogenic sources.

CALIFORNIA'S WATER QUALITY CONTROL SYSTEM

California's present system of water quality control was established in 1969, with the adoption, by the legislature, of the Porter-Cologne Water Quality Control Act. Found in Division 7 of the California Water Code, the Porter-Cologne Act is implemented by the State Water Resources Control Board and nine Regional Water Quality Control Boards. The State Water Board carries out its water quality protection authority through adoption of certain *Water Quality Control Plans,* which establish water quality standards for particular bodies of water, comprised of the beneficial uses of these waters and water quality objectives designed to protect those uses. Implementation programs needed to achieve and/or maintain the water quality objectives are also addressed in these plans. Existing *Water Quality Control Plans* adopted by the State Board include:

- The Inland Surface Waters Plan
- The Enclosed Bays and Estuaries Plan
- The Ocean Plan
- The Thermal Plan (temperature control in coastal and interstate waters and enclosed bays and estuaries)
- The Delta Plan (Sacramento-San Joaquin Delta and Suisun Marsh)
- The Lake Tahoe Basin Water Quality Plan

The State Board also adopts regulations and policies to protect water quality from discharges of waste to water or to land where water quality could be affected.

The Porter-Cologne Act separates the State of California along major drainage divides into nine Water Quality Control Regions (see the map on the inside back cover of this report). Nine Regional Water Quality Control Boards act to protect water quality within these regions through the adoption of region-specific *Water Quality Control Plans* (or "Basin Plans"). The Basin Plans contain water quality standards which are specific to waters within a specific region or part thereof. As with State Board's *Water Quality Control Plans,* implementation programs are also included in the Basin Plans. Through the issuance of waste discharge permits and water quality monitoring requirements, the Regional Boards implement state and regional *Water Quality Control Plans,* policies, and regulations. The State and Regional Water Boards also administer most of the federal clean water laws in California.

The State and Regional Boards' water quality control programs are geared toward the prevention of water pollution and nuisance. The Porter-Cologne Act defines "pollution" as "an alteration of the quality of the waters of the state by waste to a degree which unreasonably affects (1) such waters for beneficial uses, or (2) facilities which serve such beneficial uses." "Nuisance" means "anything which: (1) is injurious to health, or is indecent or offensive to the senses, or an obstruction to the free use of property so as to interfere with the comfortable enjoyment of life or property,

and (2) affects at the same time an entire community or neighborhood, or any considerable number of persons, although the extent of the annoyance or damage inflicted upon individuals may be unequal, and (3) occurs during or as the result of the treatment or disposal of wastes."

Antidegradation Policy

In 1968, the State Water Resources Control Board adopted Resolution No. 68-16, "Statement of Policy With Respect to Maintaining High Quality of Waters in California", establishing an antidegradation policy for the protection of water quality. Under this policy, whenever the existing quality of water is better than that needed to protect all existing and probable future beneficial uses of the water, such existing high quality shall be maintained until or unless it has been demonstrated to the state that any change in water quality (1) will be consistent with the maximum benefit to the people of the state and (2) will not unreasonably affect present and probable future beneficial uses of such water. Therefore, unless these conditions are met, background water quality—the concentrations of substances in natural waters which are unaffected by waste management practices or contamination incidents—are appropriate water quality goals to be maintained.

If it is determined that some water quality degradation *is* in the best interest of the people of California, some increase in pollutant concentrations above background levels may be appropriate. However, in no case may such increases cause adverse impacts to existing or probable future beneficial uses of waters of the state.

Water Quality Goals

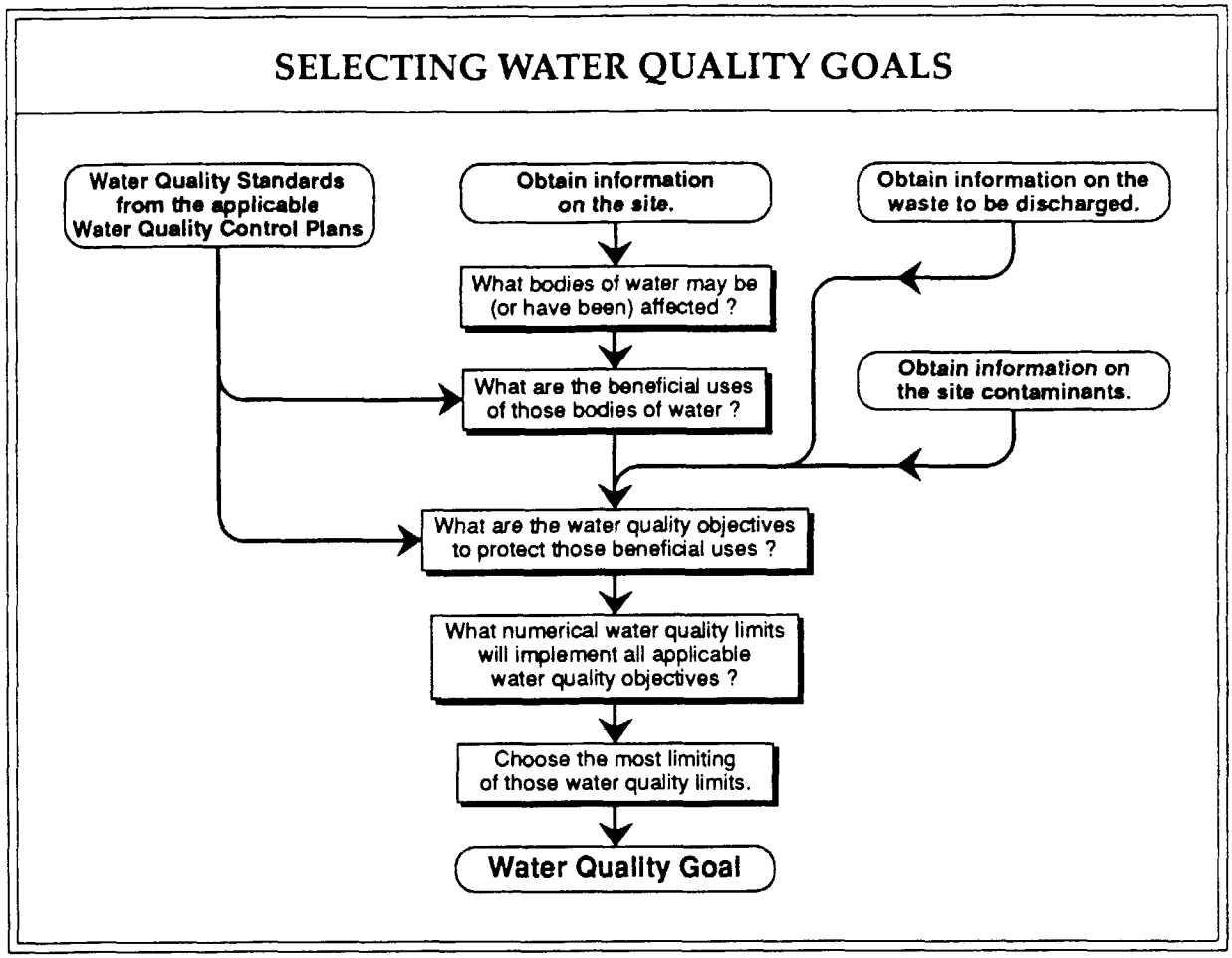
To determine whether a particular waste management activity or release of chemical constituents has caused or has the potential to cause pollution, staff of the Regional Water Quality Control Boards often determine applicable water quality goals for the pollutants involved. "Water quality goals" are numerical pollutant concentrations, above which pollutants are considered to have adversely impacted the quality of waters of the state. Water quality goals are not necessarily "water quality standards", which are defined specifically in federal regulations (see below) and which are subject to the administrative rule-making process. Rather, water quality goals also include drinking water standards, water quality criteria, advisories, and other scientific numerical values which represent concentrations of chemicals that can limit certain uses of water. In effect, these water quality goals are used to implement the narrative water quality objectives contained in the state and regional *Water Quality Control Plans*. It is from among these water quality goals (including the applicable numerical water quality objectives) that a single goal for a pollutant is selected which is most protective of all of the beneficial use(s) of the water being impacted or threatened. As mentioned above, background concentrations—levels of water quality parameters which are out of the influence of waste management activities or other anthropogenic sources—are often chosen as water quality goals. Even in cases where background levels are not used, water quality goals are selected so as to protect beneficial uses. The process of selecting water quality goals is shown in the figure at the top of the next page.

Water Quality Standards

The term "water quality standards" is defined in regulations which implement the federal Clean Water Act. That definition reads:

"Water quality standards are provisions of state or federal law which consist of a designated use or uses for the waters of the United States and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the Act."

— 40 CFR 130.2(c) and 131.3(i)



In California, the *Water Quality Control Plans* contain the state's water quality standards because these plans set forth beneficial uses of waters of the state and water quality objectives (the "criteria" under the Clean Water Act) to protect those uses. One critical difference between the state and federal programs is that while the Clean Water Act focuses on surface water resources, the term "waters of the state" under the Porter-Cologne Act includes both surface and ground waters. Therefore, California has water quality standards applicable to ground water and to surface waters.

Beneficial Uses

The first step in selecting water quality goals involves the identification of the bodies of water which have been or have the potential to be affected by the particular waste management activity or pollutant release and the present and probable future beneficial uses of these waters. The State and Regional Board *Water Quality Control Plans* list these beneficial uses of California's waters. For example, the Central Valley Region's *Water Quality Control Plan for the Sacramento River, Sacramento-San Joaquin Delta and San Joaquin River Basins* lists the following beneficial uses of ground and/or surface waters:

- Municipal and Domestic Supply
- Agricultural Supply
- Industrial Supply
  (both Service Supply and Process Supply)
- Ground Water Recharge
- Freshwater Replenishment

- Navigation
- Hydroelectric Power Generation
- Recreation
  (both Water Contact and Non-Water Contact)
- Freshwater Habitat
  (both Warm Water and Cold Water)
- Wildlife Habitat
- Preservation of Rare and Endangered Species
- Fish Migration
- Fish Spawning

The *Water Quality Control Plans* specify which beneficial uses apply to each body of water within the state. Also relevant are policies of the State and Regional Boards. For example, in 1988, the State Water Board adopted Resolution 88-63, the "Sources of Drinking Water" policy. This policy specifies that, except under specifically defined circumstances, ground and surface waters of the state are either existing or potential sources of municipal and domestic supply. Those circumstances include waters with existing high total dissolved solids concentrations (greater than 3000 mg/l), low sustainable yield (less than 200 gallons per day for a single well), waters within agricultural drains, and geothermal waters.

Water Quality Objectives

Once the beneficial uses of the relevant water bodies have been determined, the next step in selecting water quality goals is the determination of applicable water quality objectives. The Porter-Cologne Act defines "water quality objectives" as "the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area." Water quality objectives designed to protect beneficial uses and prevent nuisance are found in the *Water Quality Control Plans* of the State and Regional Boards. As with beneficial uses, water quality objectives are stated either for specific bodies of water, such as the Sacramento River between certain points, or for surface waters or ground waters throughout a basin or region. Water quality objectives come in two forms, numerical limits and narrative limits. Where numerical limits are listed in the *Water Quality Control Plans*, these values become the water quality goals for the specified constituent(s) or parameter(s) in the specified body of water. However in many cases, water quality objectives are stated in narrative form. Examples of narrative objectives, taken from the Central Valley Region's *Water Quality Control Plan for the Sacramento River, Sacramento-San Joaquin Delta and San Joaquin River Basins* are:

- Chemical Constituents —

  "Ground waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses.

  "Ground waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the maximum contaminant levels specified in California Code of Regulations, Title 22, Division 4, Chapter 15.

  "Ground waters designated for use as agricultural supply (AGR) shall not contain concentrations of chemical constituents in amounts that adversely affect such beneficial use."

- Tastes and Odors —

  "Ground waters shall not contain taste- or odor-producing substances in concentrations that cause nuisance or adversely affect beneficial uses."

- Toxicity —

  "All [inland surface] waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life."

The Central Valley Regional Water Quality Control Board's Basin Plans also contain water quality objectives for the following constituents and parameters:

- Bacteria
- Biostimulatory Substances
- Color
- Dissolved Oxygen
- Floating Material
- Metals
- Oil and Grease
- Pesticides
- pH
- Radioactivity
- Salinity
- Sediment
- Settleable Material
- Suspended Material
- Temperature
- Turbidity

Some are expressed as numerical objectives, while others are in narrative form.

Types of Numerical Water Quality Goals

Where numerical water quality objectives for a pollutant of interest do not exist in the applicable *Water Quality Control Plan(s)* and objectives are stated in narrative form, numerical water quality goals from other sources are used to implement the narrative objectives. The literature contains many useful water quality values which are designed to protect specific beneficial uses of water, which can be used as water quality goals. The following is a summary of the available types of water quality goals.

- Maximum Contaminant Levels (MCLs) —

  MCLs are part of the drinking water standards adopted both by the California Department of Health Services (DHS) in Title 22 of the California Code of Regulations (CCR), Division 4, Chapter 15, "Domestic Water Quality and Monitoring" and by the U. S. Environmental Protection Agency (U. S. EPA) under the Safe Drinking Water Act. Many of DHS's values are taken directly from the National Interim Primary Drinking Water Regulations adopted by U. S. EPA, while others are more stringent. MCLs are enforceable by DHS on water suppliers. Primary MCLs are derived from health based criteria (by U. S. EPA from MCL Goals; DHS uses 10^{-6} (one-in-a-million) incremental cancer risk levels for carcinogens and threshold toxicity levels for non-carcinogens) in conjunction with technologic and economic factors relating to the feasibility of achieving and monitoring for these concentrations in water supply systems. It should be noted that the balancing of health effects with technologic and economic considerations used in MCL derivation may not be applicable to the protection of a water resource, as will be discussed later in this paper.

  Secondary MCLs are derived from human welfare considerations (usually taste and odor) in the same manner as Primary MCLs.

- Maximum Contaminant Level Goals (MCL Goals) —

  MCL Goals are promulgated by U. S. EPA under the National Primary Drinking Water Regulations as the first step in establishing MCLs. MCL Goals are purely health-based values, and are set at "zero" for known and probable human carcinogens.

- State "Action Levels" —

  Action levels are published by DHS's Office of Drinking Water and are based mainly on health affects. The 10^{-6} incremental cancer risk

level is used for carcinogens. Organoleptic (taste and odor based) values are also included for some chemicals. Action levels are advisory to water suppliers. If exceeded, the supplier is urged to correct the problem or find an alternative raw water source.

- Proposition 65 Lawful Levels —

  Proposition 65 criteria are established by the California Environmental Protection Agency (Cal-EPA), Office of Environmental Health Hazard Assessment (OEHHA) under the California Safe Drinking Water and Toxic Enforcement Act of 1986 for known human carcinogens and reproductive toxins. They are found in Title 22 of CCR, Division 2, Chapter 3. No-Significant-Risk Levels (NSRLs) are set at the 10^{-5} (one-in-100,000) incremental cancer risk level for carcinogens. $^{1}/_{1000}$ of the No Observable Effect Level (NOEL) is used for reproductive toxicants. Prop. 65 criteria are established in the form of a dose in micrograms per day of exposure (µg/d), These values are converted into "Lawful Levels" in water by DHS by assuming 2 liters per day water consumption and 100 percent exposure to the chemical from drinking water, as recommended in draft DHS report *Evaluation of Analytical Methods in Water for the Chemicals Listed Under the California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65).*

- National Ambient Water Quality Criteria —

  These criteria are published by U. S. EPA under the Clean Water Act to protect human health and welfare and freshwater and marine aquatic life. No-Adverse-Effect Levels are presented for non-carcinogens. Incremental cancer risk estimates for carcinogens are given at the 10^{-5}, 10^{-6}, and 10^{-7} (one-in-ten-million) risk levels. Organoleptic levels are provided for some chemicals. Freshwater and saltwater aquatic life criteria and toxicity information are included. These criteria are found in:

  1) *Quality Criteria for Water, 1986* — the "Gold Book";
  2) the *Ambient Water Quality Criteria* volumes (1980, 1984, 1986, 1987, and 1989);
  3) *Quality Criteria for Water (1976)* — the "Red Book"; and
  4) *Water Quality Criteria, 1972* — the "Blue Book".

- Health Advisories and Water Quality Advisories —

  These advisories are published by U. S. EPA's Office of Drinking Water and Office of Water Regulations and Standards, respectively. Short term (10 days or less), long term (7 years or less), and lifetime exposure health advisories for non-carcinogens and suspected human carcinogens are included where data sufficient for derivation of the advisories exist. Incremental cancer risk estimates for known and probable human carcinogens are also included. Some Water Quality Advisories also contain aquatic life criteria.

- Suggested No-Adverse-Response Levels (SNARLs) —

  These human health-related criteria are published by the National Academy of Sciences in *Drinking Water and Health*, Volumes 1, 3, 4, 5, 6, and 7. SNARL values do not include a consideration of cancer risk. Incremental cancer risk estimates are also presented separately for carcinogens.

- Estimated Permissible Ambient Goals —

  Published by U. S. EPA in 1977 in *Multimedia Environmental Goals for Environmental Assessment*, these criteria are estimated from occupational exposure to airborne pollutants and, as such, are not very reliable as water quality goals. Therefore, they should only be used if no other criteria are available.

Other sources of water quality goals include:

- *Water Quality for Agriculture* published by the Food and Agriculture Organization of the United Nations in 1985, contains criteria protective of agricultural uses of water.

- *Water Quality Criteria,* written by McKee and Wolf and published by the State Water Resources Control Board in 1963 and 1978, contains criteria for human health and welfare, aquatic life, agricultural use, industrial use, and various other beneficial uses. This document is currently available from the National Technical Information Service (NTIS) as Publication No. PB 8218824.

- The California Department of Fish and Game can also supply criteria for fish and wildlife protection.

Many of these numerical water quality goals and numerical water quality objectives from the State Water Board's state-wide *Water Quality Control Plans* have been summarized in the tables which make up the remainder of this booklet.

Selecting Between Available Water Quality Goals

To protect the maximum number of beneficial uses, the most restrictive (lowest), applicable, and justifiable water quality values should be selected as the water quality goal for a particular site and pollutant. Due to the rapidly changing data base on the health and environmental effects of chemicals, caution should be observed in selecting among the various water quality values to be sure that the most recent information is utilized. The original literature should be consulted whenever possible to determine the applicability and limitations of the values being selected. Other government agencies, such as the California Department of Health Services, the California Department of Fish and Game, and the U. S. Environmental Protection Agency may be consulted for up-to-the-minute information.

It is common practice to rely on Primary MCLs as "enforceable standards" for human health. However, MCLs are intended to apply to water within a drinking water distribution system and care should be taken in the application of Primary MCLs to the protection of *sources* of drinking water. A common example of incorrect application is the use of the total trihalomethane (TTHM) MCL for the protection of ground water from chloroform. Chloroform is one of the four chemicals covered by the term "trihalomethanes". These probable human carcinogens are formed in drinking water by the action of chlorine, used for disinfection, on organic matter present in the raw source water. The TTHM Primary MCL of 100 µg/l is 18 to 526 times higher than the published 1-in-a-million incremental cancer risk estimates for chloroform. U. S. EPA has stated that the MCL for TTHMs was based mainly on technologic and economic considerations. Therefore, this drinking water standard does not clearly protect the beneficial use for municipal and domestic supply of waters of the state. The MCL for TTHMs was derived by balancing the benefit provided by the chlorination process (elimination of pathogens in drinking water) with the health threat posed by the trihalomethane by-products of this process. In the case of ground water protection, this type of cost/benefit balancing (accepting some chloroform and other THMs in order to eliminate pathogens) is not germane, and so the MCL is not sufficiently protective of the ambient quality of domestic water supply sources.

The published 1-in-a-million incremental cancer risk estimates (ranging from 0.19 to 6 µg/l) are a more accurate measure of potential impairment by chloroform of the beneficial use of ground water for domestic supply. Staff of U. S. EPA, Region 9 (San Francisco) has stated that the application of a 1-in-a-million cancer risk estimate, instead of the TTHM Primary MCL, as a water quality goal for chloroform in ground water appears to be consistent with the federal Clean Water Act and

the Safe Drinking Water Act and that the TTHM drinking water standard is not appropriate for protection of ambient water quality.

In fact, virtually all Primary MCLs are derived by balancing the technologic and economic concerns that are directly related to the use of water for domestic supply with the health effects information developed under the MCL Goal process. Thus, Primary MCLs are not necessarily reliable indicators of protection of beneficial uses of ambient waters and should not necessarily be relied upon as appropriate water quality goals in these situations. There are additional instances where water quality criteria more stringent than MCLs are applied to protect the beneficial uses of a water resource. For example, it is common practice for the Regional Water Quality Control Boards to require compliance with aquatic life criteria for heavy metal contaminants in surface waters that are often much lower than MCLs for the same contaminants.

Other factors may require water quality goals to be set below relevant water quality objectives and criteria. Care should be taken to consider other waste dischargers in the area and the contribution to the degradation of water quality that each imposes. If one discharger is permitted, through the disposal of his waste, to degrade the water resource to just below the level where beneficial uses are impaired, then no additional capacity exists for further degradation by other discharges of waste. In addition, the knowledge of the health and environmental effects of chemicals or combinations of chemicals is constantly evolving. What is considered to be safe at or below 10 µg/l today may be found to be harmful at 1 µg/l tomorrow.

An Example of Water Quality Goal Selection

Suppose you are investigating a site where a fuel tank has leaked a petroleum product into the surrounding soils. Ground water sampling results indicate that benzene, ethylbenzene , toluene, and xylene have entered ground water. You wish to know whether the levels detected in that water are of significant concern.

The first step would be to look at the *Water Quality Control Plan* (Basin Plan) for the particular Region in which your site is located. Upon examination of that document, you determine that the designated beneficial uses of the ground water are municipal and domestic supply. No numerical water quality objectives are listed in the Basin Plan for benzene, toluene, xylene, or ethylbenzene. However, there are three narrative objectives which appear to be applicable:

> "Ground waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses.
>
> "Ground waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the maximum contaminant levels specified in California Code of Regulations, Title 22, Division 4, Chapter 15.
>
> "Ground waters shall not contain taste- or odor-producing substances in concentrations that cause nuisance or adversely affect beneficial uses."

Together, these beneficial uses and water quality objectives constitute "water quality standards" for the chemical constituents in ground water at the site of your investigation.

The next step is to select numerical water quality goals from the values in the tables of this manual to help you interpret these narrative objectives. Upon examination of the Cross Reference section, you discover that listings for the constituents of concern are found in the Organic Constituents section of this manual.

The second objective from the Basin Plan, stated above, references numerical maximum contaminant levels (MCLs). These drinking water standards may be found on pages 1 through 5 of the Organic Constituents section in the first and

second columns. The applicable MCLs are:

benzene	1	µg/l
ethylbenzene	680	µg/l
xylene(s)	1750	µg/l

No California MCLs currently exist for toluene.

The third water quality objective stated above means that these waters shall not contain chemicals which impart objectionable tastes or odors. The charts on pages 1 through 5 of the Organic Constituents section contain three types of listings in which taste- and odor-based levels are found:

- California and federal Secondary MCLs
- California State Action Levels, Taste & Odor
- EPA National Ambient Water Quality Criteria based on Taste & Odor or Welfare

The following proposed Secondary MCLs are listed for the chemicals of concern:

ethylbenzene	30	µg/l
toluene	40	µg/l
xylene(s)	20	µg/l

No listings are found for benzene in these columns.

The first applicable water quality objective stated above says that chemical constituents shall not impair beneficial uses. Since the beneficial uses designated in the Basin Plan relate to consumption and/or use of water by humans, health- and welfare-related values would apply. All of the columns on pages 1 through 5 of the Organic Constituents section contain numerical limits relating to human health and welfare. (Additional health and welfare related water quality goals appear on pages 6 through 20 of this section. These goals are specific to the types of waters indicated.)

Other than the values cited above, applicable listed values for benzene include a 10-day exposure health advisory, a Proposition 65 criterion, and 10^{-6} cancer risk estimates. 10-day advisories are not protective of human health in the long term, and are, therefore, not applicable to protecting a ground water resource. The current Prop. 65 criterion for benzene is 3.5 µg/l. The cancer risk estimates are 0.66 and 1 µg/l. The most limiting value for benzene appears to be the lower cancer risk estimate. However, since this estimate forms the basis of the Primary MCL and is within the limits of analytical precision at this concentration, the Primary MCL of 1 µg/l is chosen as the water quality goal for benzene. Additionally significant is the fact that the Department of Health Services' Office of Drinking Water also supports the use of this value in protection of drinking water supplies.

For ethylbenzene, other relevant human health and welfare related values from the tables include a federal MCL and MCL Goal of 700 µg/l, an EPA health advisory of 700 µg/l, and an EPA National Ambient Water Quality Criterion of 1400 µg/l. In review, the most limiting applicable water quality goal for ethylbenzene appears to be the proposed Secondary MCL of 30 µg/l, discussed above.

Similarly, a review of other relevant values from pages 5 and 10 of the Organic Constituents section of this manual shows that all listed values for toluene and xylene are higher (less protective) than the proposed Secondary MCLs discussed above. Therefore, the most limiting and relevant water quality goals for toluene and xylene appear to be the Secondary MCLs of 40 µg/l and 20 µg/l, respectively.

In summary, the water quality goals chosen to be applicable to the protection of all beneficial uses of ground water at the site being studied are:

benzene	1	µg/l	Calif. Primary MCL
ethylbenzene	30	µg/l	prop. Secondary MCL
toluene	40	µg/l	prop. Secondary MCL
xylene	20	µg/l	prop. Secondary MCL

The reader is cautioned that these values would only apply to ground water at the hypothetical site being investigated. Other sites may have different beneficial uses and/or water quality objectives, which could alter the assessment of relevant water quality goals for these chemicals. In addition, strict application of California's antidegradation policy would indicate that background levels of these chemicals in ground water (zero for most sites) would be applicable water quality goals if some degradation in water quality is not consistent with findings made under the language of that policy, as discussed above.

	CONSTITUENT	CATEGORY	SEE LISTING(S) UNDER:
A	AAtrex	Organic	Atrazine
	Acenaphthene	Organic	Acenaphthene
	Acenaphthylene	Organic	Acenaphthylene
	Acetaldehyde	Organic	Acetaldehyde
	Acifluorfen	Organic	Acifluorfen
	Acrolein	Organic	Acrolein
	Acrylamide	Organic	Acrylamide
	Acrylonitrile	Organic	Acrylonitrile
	Alachlor	Organic	Alachlor
	Alan x	Organic	Alachlor
	Aldicarb	Organic	Aldicarb
	Aldicarb sulfone	Organic	Aldicarb sulfone
	Aldicarb sulfoxide	Organic	Aldicarb sulfoxide
	Aldrin	Organic	Aldrin
	Alkalinity	Inorganic	Alkalinity
	Allyl chloride	Organic	3-Chloropropene
	Allyl trichloride	Organic	1,2,3-Trichloropropane
	Aluminum	Inorganic	Aluminum
	Ametryn	Organic	Ametryn
	Ametrex	Organic	Ametryn
	Amiben	Organic	Chloramben
	Ammonia	Inorganic	Ammonia
	Ammonium sulfamate	Inorganic	Ammonium sulfamate
	Aniline	Organic	Aniline
	Antergon	Organic	Maleic hydrazide
	Anthracene	Organic	Anthracene
	Antimony	Inorganic	Antimony
	Aquacide	Organic	Diquat
	Arsenic	Inorganic	Arsenic
	Asbestos	Inorganic	Asbestos
	Atrazine	Organic	Atrazine
	Azinphos-methyl	Organic	Azinphos-methyl
	Azobenzene	Organic	Azobenzene
B	Balan	Organic	Benefin
	Banvel	Organic	Dicamba
	Barium	Inorganic	Barium
	Basagran	Organic	Bentazon
	Baygon	Organic	Baygon
	Benefin	Organic	Benefin
	Benfluralin	Organic	Benefin
	Bentazon	Organic	Bentazon
	Benthiocarb	Organic	Thiobencarb
	Benz(a)anthracene	Organic	Benz(a)anthracene
	1,2-Benzanthracene	Organic	Benz(a)anthracene
	Benzene	Organic	Benzene
	Benzene hexachloride	Organic	alpha-BHC beta-BHC gamma-BHC (Lindane) delta-BHC technical-BHC
	Benzenes, chlorinated	Organic	Benzenes, chlorinated Benzenes, dichloro- Benzenes, trichloro- Chlorobenzene 1,2-Dichlorobenzene 1,3-Dichlorobenzene 1,4-Dichlorobenzene Hexachlorobenzene Pentachlorobenzene 1,2,4,5-Tetrachlorobenzene 1,2,4-Trichlorobenzene
	Benzenes, dichloro-	Organic	Benzenes, dichloro- 1,2-Dichlorobenzene 1,3-Dichlorobenzene 1,4-Dichlorobenzene
	Benzenes, trichloro-	Organic	Benzenes, trichloro- 1,2,4-Trichlorobenzene
	Benzidine	Organic	Benzidine
	Benzidines, dichloro-	Organic	Benzidines, dichloro- 3,3'-Dichlorobenzidine
	Benzo(b)fluoranthene	Organic	Benzo(b)fluoranthene
	3,4-Benzofluoranthene	Organic	Benzo(b)fluoranthene
	Benzo(k)fluoranthene	Organic	Benzo(k)fluoranthene
	Benzo(g,h,i)perylene	Organic	Benzo(g,h,i)perylene
	1,12-Benzoperylene	Organic	Benzo(g,h,i)perylene
	Benzo(a)pyrene	Organic	Benzo(a)pyrene
	Benzyl butyl phthalate	Organic	n-Butyl benzyl phthalate
	Beryllium	Inorganic	Beryllium
	BHC	Organic	alpha-BHC beta-BHC gamma-BHC (Lindane) delta-BHC technical-BHC
	alpha-BHC	Organic	alpha-BHC
	beta-BHC	Organic	beta-BHC
	gamma-BHC	Organic	gamma-BHC (Lindane)
	delta-BHC	Organic	delta-BHC
	technical-BHC	Organic	technical-BHC
	Bis-butyl phthalate	Organic	Dibutyl phthalate
	Bis(2-chloroethoxy) methane	Organic	Bis(2-chloroethoxy) methane
	Bis(2-chloroethyl) ether	Organic	Bis(2-chloroethyl) ether

	CONSTITUENT	CATEGORY	SEE LISTING(S) UNDER:
	Bis(2-chloroisopropyl) ether	Organic	Bis(2-chloroisopropyl) ether
	Bis(chloromethyl) ether	Organic	Bis(chloromethyl) ether
	Bis-ethyl phthalate	Organic	Diethyl phthalate
	Bis(2-ethylhexyl) phthalate	Organic	Di(2-ethylhexyl) phthalate
	Bis-methyl phthalate	Organic	Dimethyl phthalate
	Bis-n-octyl phthalate	Organic	Di(n-octyl) phthalate
	Bladex	Organic	Cyanazine
	Blazer	Organic	Acifluorfen
	Bolero	Organic	Thiobencarb
	Boron	Inorganic	Boron
	Bravo	Organic	Chlorothalonil
	Bromacil	Organic	Bromacil
	Bromide	Inorganic	Bromide
	Bromochloromethane	Organic	Bromochloromethane
	Bromodichloromethane	Organic	Bromodichloromethane
	Bromoform	Organic	Bromoform
	Bromomethane	Organic	Bromomethane
	4-Bromophenyl phenyl ether	Organic	4-Bromophenyl phenyl ether
	Butachlor	Organic	Butachlor
	1,3-Butadiene	Organic	1,3-Butadiene
	Butanex	Organic	Butachlor
	2-Butanone	Organic	Methyl ethyl ketone (MEK)
	Butylate	Organic	Butylate
	n-Butyl benzyl phthalate	Organic	n-Butyl benzyl phthalate
C	Cadmium	Inorganic	Cadmium
	Camphechlor	Organic	Toxaphene
	Captan	Organic	Captan
	Carbamate	Organic	Ferbam
	Carbaryl	Organic	Carbaryl
	Carbathiin	Organic	Carboxin
	Carbofuran	Organic	Carbofuran
	Carbon tetrachloride	Organic	Carbon tetrachloride
	Carbophenothion	Organic	Trithion
	Carboxin	Organic	Carboxin
	Carboxine	Organic	Carboxin
	Catechol	Organic	Catechol
	CDEC	Organic	Sulfallate
	Chemform	Organic	Maleic hydrazide
	Chloral hydrate	Organic	Trichloroacetaldehyde, hydrated
	Chloramben	Organic	Chloramben
	Chloramine	Inorganic	Chloramine
	Chlorate	Inorganic	Chlorate
	Chlordan	Organic	Chlordane
	Chlordane	Organic	Chlordane
	Chlordecone	Organic	Kepone
	Chloride	Inorganic	Chloride
	Chlorinated benzenes	Organic	Benzenes, chlorinated Benzenes, dichloro- Benzenes, trichloro- Chlorobenzene 1,2-Dichlorobenzene 1,3-Dichlorobenzene 1,4-Dichlorobenzene Hexachlorobenzene Pentachlorobenzene 1,2,4,5-Tetrachlorobenzene 1,2,4-Trichlorobenzene 1,3,5-Trichlorobenzene
	Chlorinated naphthalenes	Organic	Naphthalenes, chlorinated 2-Chloronaphthalene
	Chlorinated phenols	Organic	Phenols, chlorinated 4-Chloro-o-cresol 4-Chloro-m-cresol 6-Chloro-m-cresol 2-Chlorophenol 3-Chlorophenol 4-Chlorophenol 2,3-Dichlorophenol 2,4-Dichlorophenol 2,5-Dichlorophenol 2,6-Dichlorophenol 3,4-Dichlorophenol Pentachlorophenol 2,3,4,6-Tetrachlorophenol 2,3,5,6-Tetrachlorophenol 2,4,5-Trichlorophenol 2,4,6-Trichlorophenol
	Chlorine	Inorganic	Chlorine
	Chlorine dioxide	Inorganic	Chlorine dioxide
	Chlorite	Inorganic	Chlorite
	Chloroalkyl ethers	Organic	Ethers, chloroalkyl- Bis(2-chloroethyl) ether Bis(2-chloroisopropyl) ether Bis(chloromethyl) ether
	2-Chloroalkyl-diethyldithiocarbamate	Organic	Sulfallate
	Chlorobenzene	Organic	Chlorobenzene
	Chlorobromomethane	Organic	Bromochloromethane
	p-Chloro-o-cresol	Organic	4-Chloro-o-cresol
	4-Chloro-o-cresol	Organic	4-Chloro-o-cresol
	p-Chloro-m-cresol	Organic	4-Chloro-m-cresol
	4-Chloro-m-cresol	Organic	4-Chloro-m-cresol

CONSTITUENT	CATEGORY	SEE LISTING(S) UNDER:
6-Chloro-m-cresol	Organic	6-Chloro-m-cresol
Chlorodibromomethane	Organic	Dibromochloromethane
Chloroethene	Organic	Vinyl chloride
Chloroethylene	Organic	Vinyl chloride
Chloroform	Organic	Chloroform
Chlorofos	Organic	Trichlorfon
Chloro-IPC	Organic	Chlorpropham
Chloromethane	Organic	Chloromethane
4-Chloro-2-methylphenol	Organic	4-Chloro-o-cresol
4-Chloro-3-methylphenol	Organic	4-Chloro-m cresol
6-Chloro-3-methylphenol	Organic	6-Chloro-m-cresol
2-Chloronaphthalene	Organic	2-Chloronaphthalene
2-Chlorophenol	Organic	2-Chlorophenol
3-Chlorophenol	Organic	3-Chlorophenol
4-Chlorophenol	Organic	4-Chlorophenol
m-Chlorophenol	Organic	3-Chlorophenol
o-Chlorophenol	Organic	2-Chlorophenol
p-Chlorophenol	Organic	4-Chlorophenol
Chloropicrin	Organic	Chloropicrin
3-Chloropropene	Organic	3-Chloropropene
Chlorothalonil	Organic	Chlorothalonil
2-Chlorotoluene	Organic	2-Chlorotoluene
4-Chlorotoluene	Organic	4-Chlorotoluene
o-Chlorotoluene	Organic	2-Chlorotoluene
p-Chlorotoluene	Organic	4-Chlorotoluene
Chlorpropham	Organic	Chlorpropham
Chlorpyrifos	Organic	Chlorpyrifos
Chromium III	Inorganic	Chromium III
Chromium VI	Inorganic	Chromium VI
Chromium (Total)	Inorganic	Chromium VI
Chrysanthemumic acid	Organic	Dimethrin
Chrysene	Organic	Chrysene
CIPC	Organic	Chlorpropham
Cobalt	Inorganic	Cobalt
Color	Inorganic	Color
Contraven	Organic	Terbufos
Copper	Inorganic	Copper
Cotoron	Organic	Fluometuron
Cottonex	Organic	Fluometuron
Counter	Organic	Terbufos
Crisuron	Organic	Diuron
Cyanazine	Organic	Cyanazine
Cyanide	Inorganic	Cyanide
Cyclotetramethylene tetranitramine	Organic	HMX
Cyclotrimethylene trinitramine	Organic	RDX (Cyclonite)
Cyclonite	Organic	RDX (Cyclonite)
Cygon	Organic	Dimethoate
Cythion	Organic	Malathion
D 2,4-D	Organic	2,4-D
Daconil	Organic	Chlorothalonil
Dacthal	Organic	Dacthal (DCPA)
Dalapon	Organic	Dalapon
DBCP	Organic	DBCP
1,1-DCA	Organic	1,1-Dichloroethane
1,2-DCA	Organic	1,2-Dichloroethane
DCB	Organic	3,3'-Dichlorobenzidine
1,1-DCE	Organic	1,1-Dichloroethylene
DCPA	Organic	Dacthal (DCPA)
D-D Mixture	Organic	1,2-Dichloropropane 1,3-Dichloropropene Propanes, dichloro- Propenes, dichloro-
DDD	Organic	DDD
4,4'-DDD	Organic	DDD
DDE	Organic	DDE
4,4'-DDE	Organic	DDE
DDT	Organic	DDT
4,4'-DDT	Organic	DDT
DDVP	Organic	Dichlorvos
Dechlorane	Organic	Mirex
De-Fend	Organic	Dimethoate
DEHP	Organic	Di(2-ethylhexyl) phthalate
Demeton	Organic	Demeton
Dialon	Organic	Diuron
Diazinon	Organic	Diazinon
Dibenz(a,h)anthracene	Organic	Dibenz(a,h)anthracene
1,2;5,6-Dibenzanthracene	Organic	Dibenz(a,h)anthracene
Dibromoacetonitrile	Organic	Dibromoacetonitrile
Dibromochloromethane	Organic	Dibromochloromethane
Dibromochloropropane	Organic	DBCP
1,2-Dibromo-3-chloropropane	Organic	DBCP
Dibromochloropropane	Organic	DBCP
1,2-Dibromo-3-chloropropane	Organic	DBCP
1,2-Dibromoethane	Organic	Ethylene dibromide (EDB)
1,2-Dibromomethane	Organic	Ethylene dibromide (EDB)
Dibutylnitrosamine	Organic	N-Nitrosodibutylamine
Dibutyl phthalate	Organic	Dibutyl phthalate
Dicamba	Organic	Dicamba
Dichloroacetic acid	Organic	Dichloroacetic acid
Dichloroacetonitrile	Organic	Dichloroacetonitrile
1,2-Dichlorobenzene	Organic	1,2-Dichlorobenzene

CONSTITUENT	CATEGORY	SEE LISTING(S) UNDER:
1,3-Dichlorobenzene	Organic	1,3-Dichlorobenzene
1,4-Dichlorobenzene	Organic	1,4-Dichlorobenzene
m-Dichlorobenzene	Organic	1,3-Dichlorobenzene
o-Dichlorobenzene	Organic	1,2-Dichlorobenzene
p-Dichlorobenzene	Organic	1,4-Dichlorobenzene
Dichlorobenzenes	Organic	Benzenes, dichloro- 1,2-Dichlorobenzene 1,3-Dichlorobenzene 1,4-Dichlorobenzene
3,3'-Dichlorobenzidine	Organic	3,3'-Dichlorobenzidine
Dichlorobenzidines	Organic	Benzidines, dichloro- 3,3'-Dichlorobenzidene
1,1-Dichloro-2,2-bis(p-chlorophenyl)ethane	Organic	DDD
Dichlorobromomethane	Organic	Bromodichloromethane
Dichlorodifluoromethane	Organic	Dichlorodifluoromethane
Dichlorodiphenyldichloroethylene	Organic	DDE
Dichlorodiphenyltrichloroethane	Organic	DDT
1,1-Dichloroethane	Organic	1,1-Dichloroethane
1,2-Dichloroethane	Organic	1,2-Dichloroethane
1,1-Dichloroethene	Organic	1,1-Dichloroethylene
cis-1,2-Dichloroethene	Organic	cis-1,2-Dichloroethylene
trans-1,2-Dichloroethene	Organic	trans-1,2-Dichloroethylene
Dichloroethenes	Organic	Ethylenes, dichloro- 1,1-Dichloroethylene cis-1,2-Dichloroethylene trans-1,2-Dichloroethylene
1,1-Dichloroethylene	Organic	1,1-Dichloroethylene
cis-1,2-Dichloroethylene	Organic	cis-1,2-Dichloroethylene
trans-1,2-Dichloroethylene	Organic	trans-1,2-Dichloroethylene
Dichloroethylenes	Organic	Ethylenes, dichloro- 1,1-Dichloroethylene cis-1,2-Dichloroethylene trans-1,2-Dichloroethylene
Dichloromethane	Organic	Dichloromethane
2,3-Dichlorophenol	Organic	2,3-Dichlorophenol
2,4-Dichlorophenol	Organic	2,4-Dichlorophenol
2,5-Dichlorophenol	Organic	2,5-Dichlorophenol
2,6-Dichlorophenol	Organic	2,6-Dichlorophenol
3,4-Dichlorophenol	Organic	3,4-Dichlorophenol
2,4-Dichlorophenoxyacetic acid	Organic	2,4-D
1,2-Dichloropropane	Organic	1,2-Dichloropropane
Dichloropropanes	Organic	Propanes, dichloro- 1,2-Dichloropropane
1,3-Dichloropropene	Organic	1,3-Dichloropropene
cis-1,3-Dichloropropene	Organic	1,3-Dichloropropene
trans-1,3-Dichloropropene	Organic	1,3-Dichloropropene
Dichloropropenes	Organic	Propenes, dichloro- 1,3-Dichloropropene
2,2-Dichloropropionic acid	Organic	Dalpon
Dichlorvos	Organic	Dichlorvos
Dieldrin	Organic	Dieldrin
Diesel Oil	Organic	Diesel Oil
Diethion	Organic	Ethion
Diethyl phthalate	Organic	Diethyl phthalate
Di(ethylhexyl) adipate	Organic	Di(ethylhexyl) adipate
Di(2-ethylhexyl) phthalate	Organic	Di(2-ethylhexyl) phthalate
Difluorodichloromethane	Organic	Dichlorodifluoromethane
Difonate	Organic	Fondfos
Diisopropyl methyl phosphonate	Organic	Diisopropyl methyl phosphonate
Dimethoate	Organic	Dimethoate
Dimethrin	Organic	Dimethrin
2,4-Dimethylbenzylester	Organic	Dimethrin
Dimethyl phthalate	Organic	Dimethyl phthalate
2,4-Dimethylphenol	Organic	2,4-Dimethylphenol
1,3-Dinitrobenzene	Organic	1,3-Dinitrobenzene
m-Dinitrobenzene	Organic	1,3-Dinitrobenzene
2,4-Dinitro-o-cresol	Organic	2,4-Dinitro-o-cresol
Dinitrophenol	Organic	Dinitrophenol
2,4-Dinitrophenol	Organic	2,4-Dinitrophenol
Dinitrophenols	Organic	Dinitrophenol
2,4-Dinitrotoluene	Organic	2,4-Dinitrotoluene
2,6-Dinitrotoluene	Organic	2,6-Dinitrotoluene
Dinoseb	Organic	Dinoseb
Di(n-octyl) phthalate	Organic	Di(n-octyl) phthalate
p-Dioxane	Organic	1,4-Dioxane
1,4-Dioxane	Organic	1,4-Dioxane
Dioxin	Organic	2,3,7,8-TCDD (Dioxin)
Diphenamid	Organic	Diphenamid
Diphenyldiimide	Organic	Azobenzene
1,2-Diphenylhydrazine	Organic	1,2-Diphenylhydrazine
Diphenylnitrosamine	Organic	N-Nitrosodiphenylamine
Dipropylnitrosamine	Organic	N-Nitrosodipropylamine
Dipterex	Organic	Trichlorfon
Diquat	Organic	Diquat
Disulfoton	Organic	Disyston (Disulfoton)
Disyston	Organic	Disyston (Disulfoton)
Dithane D-14	Organic	Nabam
Dithane M-22	Organic	Maneb
Dithane Z-78	Organic	Zineb
Diurex	Organic	Diuron
Diuron	Organic	Diuron
DNBP	Organic	Dinoseb

	CONSTITUENT	CATEGORY	SEE LISTING(S) UNDER:
	Dowpon	Organic	Dalpon
	Dual	Organic	Metolachlor
	Dursban	Organic	Chlorpyrifos
	Dyfonate	Organic	Fonofos
	Dyphonate	Organic	Fonofos
E	EC	Inorganic	Specific conductance (EC)
	EDB	Organic	Ethylene dibromide (EDB)
	Endosulfan	Organic	Endosulfan
	Endosulfan I	Organic	Endosulfan
	Endosulfan II	Organic	Endosulfan
	Endosulfan sulfate	Organic	Endosulfan sulfate
	Endothal	Organic	Endothall
	Endothall	Organic	Endothall
	Endrex	Organic	Endrin
	Endrin	Organic	Endrin
	Epic 500	Organic	Furmecyclox
	Epichlorohydrin	Organic	Epichlorohydrin
	1,2-Ethane diol	Organic	Ethylene glycol
	Ethers, chloroalkyl-	Organic	Ethers, chloroalkyl- Bis(2-chloroehtyl) ether Bis(2-chloroisopropyl) ether Bis(chloromethyl) ether
	Ethers, halo-	Organic	Ethers, halo- Bis(2-chloroehtyl) ether Bis(2-chloroisopropyl) ether Bis(chloromethyl) ether 4-Bromophenyl phenyl ether Ethers, chloroalkyl-
	Ethion	Organic	Ethion
	Ethyl carbamate	Organic	Urethane
	Ethyl parathion	Organic	Parathion
	Ethylbenzene	Organic	Ethylbenzene
	Ethylene dibromide	Organic	Ethylene dibromide (EDB)
	Ethylene dichloride	Organic	1,2-Dichloroethane
	Ethylene glycol	Organic	Ethylene glycol
	Ethylene oxide	Organic	Ethylene oxide (ETO)
	Ethylenes, dichloro-	Organic	Ethylenes, dichloro- 1,1-Dichloroethylene cis-1,2-Dichloroethylene trans-1,2-Dichloroethylene
	Ethylene thiourea	Organic	Ethylene thiourea (ETU) Ferbam Maneb Nabam Thiram Zineb Ziram
	Ethylthiodemeton	Organic	Disyston (Disulfoton)
	ETU	Organic	Ethylene thiourea (ETU) Ferbam Maneb Nabam Thiram Zineb Ziram
	Fenamiphos	Organic	Fenamiphos
F	Ferbam	Organic	Ferbam
	Fermate	Organic	Ferbam
	Fluometuron	Organic	Fluometuron
	Fluoranthene	Organic	Fluoranthene
	Fluorene	Organic	Fluorene
	Fluoride	Inorganic	Fluoride
	Fluorotrichloromethane	Organic	Trichlorofluoromethane
	Foaming agents (organic & inorganic)	Inorganic	Foaming agents (MBAS)
	Folpan	Organic	Folpet
	Folpet	Organic	Folpet
	Fonofos	Organic	Fonofos
	Formaldehyde	Organic	Formaldehyde
	Fostamid	Organic	Dimethoate
	Freon 10	Organic	Carbon tetrachloride
	Freon 11	Organic	Trichlorofluoromethane
	Freon 12	Organic	Dichlorodifluoromethane
	Freon 20	Organic	Chloroform
	Freon 113	Organic	Trichlorotrifluoroethane
	Fuel oil #1	Organic	Kerosene
	Fuel oil #2	Organic	Diesel Oil
	Furadan	Organic	Carbofuran
	Furmecyclox	Organic	Furmecyclox
	Gesafram 50	Organic	Prometon
G	Glyphosate	Organic	Glyphosate
	Glyphosate isopropylamine salt	Organic	Glyphosate
	Grasian	Organic	Tebuthiuron
	Grease & oil	Organic	Oil & grease
	Guthion	Organic	Azinphos-methyl
H	Haloethers	Organic	Ethers, halo- Bis(2-chloroehtyl) ether Bis(2-chloroisopropyl) ether Bis(chloromethyl) ether

	CONSTITUENT	CATEGORY	SEE LISTING(S) UNDER:
	Haloethers (cont.)	Organic	4-Bromophenyl phenyl ether Ethers, chloroalkyl-
	Halomethanes	Organic	Methanes, halo- Bromodichloromethane Bromoform Bromomethane Carbon tetrachloride Chloroform Chloromethane Dibromochloromethane Dichlorodifluoromethane Dichloromethane Trichlorofluoromethane
	Hardness	Inorganic	Hardness
	HCH	Organic	BHC
	Heptachlor	Organic	Heptachlor
	Heptachlor epoxide	Organic	Heptachlor epoxide
	HEX	Organic	Hexachlorocyclopentadiene
	Hexachlorobenzene	Organic	Hexachlorobenzene
	Hexachlorobutadiene	Organic	Hexachlorobutadiene
	Hexachlorocyclohexane	Organic	alpha-BHC beta-BHC gamma-BHC (Lindane) delta-BHC technical-BHC
	Hexachlorocyclopentadiene	Organic	Hexachlorocyclopentadiene
	Hexachloroethane	Organic	Hexachloroethane
	Hexachlorophene	Organic	Hexachlorophene
	Hexadrin	Organic	Endrin
	Hexane	Organic	n-Hexane
	n-Hexane	Organic	n-Hexane
	Hexazinone	Organic	Hexazinone
	Hexogen	Organic	RDX (Cyclonite)
	HMX	Organic	HMX
	Hydrazine	Inorganic	Hydrazine
	Hydrazine sulfate	Inorganic	Hydrazine sulfate
	Hydrogen sulfide	Inorganic	Hydrogen sulfide
	Hyvar X or XL	Organic	Bromacil
I	Indeno(1,2,3-c,d)pyrene	Organic	Indeno(1,2,3-c,d)pyrene
	Iodide	Inorganic	Iodide
	Iron	Inorganic	Iron
	Isophorone	Organic	Isophorone
	Isopropanol	Organic	Isopropanol
	Isopropyl alcohol	Organic	Isopropanol
	Isopropyl N (3-chlorophenyl) carbamate	Organic	Chlorpropham
K	Karmex	Organic	Diuron
	Kepone	Organic	Kepone
	Kerb	Organic	Pronamide
	Kerosene	Organic	Kerosene
	Kerosine	Organic	Kerosene
	Krovar	Organic	Diuron
L	Lambast	Organic	Butachlor
	Lanex	Organic	Fluometuron
	Lannate	Organic	Methomyl
	Lasso	Organic	Alachlor
	Lead (Inorganic)	Inorganic	Lead (Inorganic)
	Lindane	Organic	gamma-BHC (Lindane)
	Lorsban	Organic	Chlorpyrifos
M	Malathion	Organic	Malathion
	Maleic hydrazide	Organic	Maleic hydrazide
	Maneb	Organic	Maneb
	Manganese	Inorganic	Manganese
	Manzate	Organic	Maneb
	MCPA	Organic	MCPA
	MEK	Organic	Methyl ethyl ketone (MEK)
	Mercury	Inorganic	Mercury
	Methanes, halo-	Organic	Methanes, halo- Bromodichloromethane Bromoform Bromomethane Carbon tetrachloride Chloroform Chloromethane Dibromochloromethane Dichlorodifluoromethane Dichloromethane Trichlorofluoromethane
	Methomyl	Organic	Methomyl
	Methoxychlor	Organic	Methoxychlor
	Methoxypropazine	Organic	Prometon
	Methyl benzene	Organic	Toluene
	Methyl bromide	Organic	Bromomethane
	Methyl t-butyl ether	Organic	Methyl t-butyl ether (MTBE)
	Methyl chloride	Organic	Chloromethane
	Methyl chloroform	Organic	1,1,1-Trichloroethane
	2-Methyl-4-chlorophenol	Organic	4-Chloro-o-cresol
	3-Methyl-4-chlorophenol	Organic	4-Chloro-m-cresol
	3-Methyl-6-chlorophenol	Organic	6-Chloro-m-cresol

	CONSTITUENT	CATEGORY	SEE LISTING(S) UNDER:
	2-Methyl-4-chlorophenoxyacetic acid	Organic	MCPA
	2-Methyl-4,6-dinitrophenol	Organic	4,6-Dinitro-o-cresol
	4,4'-Methylenebis(N,N-dimethylaniline)	Organic	4,4'-Methylenebis(N,N-dimethylaniline)
	4,4'-Methylenebis(N,N-dimethyl)benzeneamine	Organic	4,4'-Methylenebis(N,N-dimethylaniline)
	Methylene chloride	Organic	Dichloromethane
	Methyl ethyl ketone	Organic	Methyl ethyl ketone (MEK)
	Methyl ethyl nitrosamine	Organic	N-Nitrosomethylethylamine
	Methyl methacrylate	Organic	Methyl methacrylate
	Methyl parathion	Organic	Methyl parathion
	Metolachlor	Organic	Metolachlor
	Metribuzin	Organic	Metribuzin
	Milogard	Organic	Propazine
	Mirex	Organic	Mirex
	Molinate	Organic	Molinate
	Molybdenum	Inorganic	Molybdenum
	Monochlorobenzene	Organic	Chlorobenzene
	Mononitrophenols	Organic	Nitrophenol 2-Nitrophenol 4-Nitrophenol
	MTBE	Organic	Methyl t-butyl ether (MTBE)
N	Nabam	Organic	Nabam
	Naphthalene	Organic	Naphthalene
	Naphthalenes, chlorinated	Organic	Naphthalenes, chlorinated 2-Chloronaphthalene
	Nemacur	Organic	Fenamiphos
	Nickel	Inorganic	Nickel
	Nitralin	Organic	Nitralin
	Nitrate	Inorganic	Nitrate
	Nitrite	Inorganic	Nitrite
	Nitrobenzene	Organic	Nitrobenzene
	Nitrofen	Organic	Nitrofen
	Nitroguanidine	Organic	Nitroguanidine
	Nitrofene	Organic	Nitrofen
	Nitrophenol	Organic	Nitrophenol
	2-Nitrophenol	Organic	2-Nitrophenol
	4-Nitrophenol	Organic	4-Nitrophenol
	o-Nitrophenol	Organic	2-Nitrophenol
	p-Nitrophenol	Organic	4-Nitrophenol
	Nitrophenols	Organic	Phenols, nitro- 2,4-Dinitro-o-cresol Dinitrophenol Nitrophenol 2-Nitrophenol 4-Nitrophenol Trinitrophenol
	Nitrosamines	Organic	Nitrosamines N-Nitrosodibutylamine N-Nitrosodiethanolamine N-Nitrosodiethylamine N-Nitrosodimethylamine N-Nitrosodiphenylamine N-Nitrosodipropylamine N-Nitrosomethylethylamine N-Nitrosopyrrolidine
	N-Nitrosodibutylamine	Organic	N-Nitrosodi-n-butylamine
	N-Nitrosodiethanolamine	Organic	N-Nitrosodiethanolamine
	N-Nitrosodiethylamine	Organic	N-Nitrosodiethylamine
	N-Nitrosodimethylamine	Organic	N-Nitrosodimethylamine
	N-Nitrosodiphenylamine	Organic	N-Nitrosodiphenylamine
	N-Nitrosodipropylamine	Organic	N-Nitrosodipropylamine
	N-Nitroso-N-ethylurea	Organic	N-Nitroso-N-ethylurea
	N-Nitrosomethylethylamine	Organic	N-Nitrosomethylethylamine
	N-Nitroso-N-methylurea	Organic	N-Nitroso-N-methylurea
	N-Nitrosopyrrolidine	Organic	N-Nitrosopyrrolidine
	Nonachlor	Organic	trans-Nonachlor
	trans-Nonachlor	Organic	trans-Nonachlor
	Nonchlorinated phenols	Organic	Phenols, nonchlorinated Catechol 2,4-Dimethylphenol 2,3-Dinitro-o-cresol Dinitrophenol Nitrophenol 2-Nitrophenol 4-Nitrophenol Phenol Phenols, nitro- Resorcinol Trinitrophenol
O	Oil & grease	Organic	Oil & grease
	Ordram	Organic	Molinate
	Orthocide	Organic	Captan
	Ortho paraquat	Organic	Paraquat
	Oxamyl	Organic	Oxamyl
	Oxychlordane	Organic	Oxychlordane
	Oxygen, dissolved	Inorganic	Oxygen, dissolved
P	PAHs	Organic	PAHs Acenaphthylene Anthracene Benz(a)anthracene

CONSTITUENT	CATEGORY	SEE LISTING(S) UNDER:
PAHs (cont.)	Organic	Benzo(b)fluoranthene Benzo(k)fluoranthene Benzo(g,h,i)perylene Benzo(a)pyrene Chrysene Dibenz(a,h)anthracene Fluoranthene Fluorene Indeno(1,2,3-c,d)pyrene Phenanthrene Pyrene
Paraquat	Organic	Paraquat
Parathion	Organic	Parathion
Parathion-methyl	Organic	Methyl parathion
PBBs	Organic	Polybrominated biphenyls
PCBs	Organic	Polychlorinated biphenyls
PCE	Organic	Tetrachloroethylene (PCE)
PCNB	Organic	Pentachloronitrobenzene
PCP	Organic	Pentachlorophenol
PDB	Organic	1,4-Dichlorobenzene
Penta	Organic	Pentachlorophenol
Pentachlorobenzene	Organic	Pentachlorobenzene
Pentachloroethane	Organic	Pentachloroethane
Pentachloronitrobenzene	Organic	Pentachloronitrobenzene
Pentachlorophenol	Organic	Pentachlorophenol
Perchlorobutadiene	Organic	Hexachlorobutadiene
Perchloroethylene	Organic	Tetrachloroethylene (PCE)
Perfian	Organic	Tebuthiuron
pH	Inorganic	pH
Phenamiphos	Organic	Fenamiphos
Phenanthrene	Organic	Phenanthrene
Phenol	Organic	Phenol
Phenols, chlorinated	Organic	Phenols, chlorinated 4-Chloro-o-cresol 4-Chloro-m-cresol 6-Chloro-m-cresol 2-Chlorophenol 3-Chlorophenol 4-Chlorophenol 2,3-Dichlorophenol 2,4-Dichlorophenol 2,5-Dichlorophenol 2,6-Dichlorophenol 3,4-Dichlorophenol Pentachlorophenol 2,3,4,6-Tetrachlorophenol 2,3,5,6-Tetrachlorophenol 2,4,5-Trichlorophenol 2,4,6-Trichlorophenol
Phenols, nonchlorinated	Organic	Phenols, nonchlorinated Catechol 2,4-Dimethylphenol 2,4-Dinitro-o-cresol Dinitrophenol Nitrophenol 2-Nitrophenol 4-Nitrophenol Phenol Phenols, nitro- Resorcinol Trinitrophenol
Phenols, nitro-	Organic	Phenols, nitro- 2,4-Dinitro-o-cresol Dinitrophenol Nitrophenol 2-Nitrophenol 4-Nitrophenol Trinitrophenol
Phenyl ethane	Organic	Ethylbenzene
Phorate	Organic	Phorate
Phosphorus	Inorganic	Phosphorus
Phthalate esters	Organic	Phthalate esters n-Butyl benzyl phthalate Dibutyl phthalate Di(2-ethylhexyl) phthalate Diethyl phthalate Dimethyl phthalate Di(n-octyl) phthalate
Picloram	Organic	Picloram
Picric acid	Organic	Trinitrophenol
Planavin	Organic	Nitralin
PNAs	Organic	PAHs Acenaphthylene Anthracene Benz(a)anthracene Benzo(b)fluoranthene Benzo(k)fluoranthene Benzo(g,h,i)perylene Benzo(a)pyrene Chrysene Dibenz(a,h)anthracene Fluoranthene

	CONSTITUENT	CATEGORY	SEE LISTING(S) UNDER:
	PNAs (cont.)	Organic	Fluorene Indeno(1,2,3-c,d)pyrene Phenanthrene Pyrene
	Polybrominated biphenyls	Organic	Polybrominated biphenyls
	Polychlorinated biphenyls	Organic	Polychlorinated biphenyls
	Polynuclear aromatic hydrocarbons	Organic	PAHs Acenaphthylene Anthracene Benz(a)anthracene Benzo(b)fluoranthene Benzo(k)fluoranthene Benzo(g,h,i)perylene Benzo(a)pyrene Chrysene Dibenz(a,h)anthracene Fluoranthene Fluorene Indeno(1,2,3-c,d)pyrene Phenanthrene Pyrene
	Pramitol	Organic	Prometon
	Princep	Organic	Simazine
	Profam	Organic	Propham
	Prometon	Organic	Prometon
	Pronamide	Organic	Pronamide
	Propachlor	Organic	Propachlor
	Propanes, dichloro-	Organic	Propanes, dichloro- 1,2-Dichloropropane
	Propanil	Organic	Propanil
	Propazine	Organic	Propazine
	Propeneamide	Organic	Acrylamide
	Propenes, dichloro-	Organic	Propenes, dichloro- 1,3-Dichloropropene
	Propham	Organic	Propham
	Prophos	Organic	Propham
	Propoxur	Organic	Baygon
	Propylene dichloride	Organic	1,2-Dichloropropane
	Propyzamide	Organic	Pronamide
	Pyrene	Organic	Pyrene
Q	Quintozine	Organic	Terracior
R	Radon	Inorganic	Radon
	Ramrod	Organic	Propachlor
	RDX	Organic	RDX (Cyclonite)
	Reglone	Organic	Diquat
	Resorcinol	Organic	Resorcinol
	Retard	Organic	Maleic hydrazide
	Rotenone	Organic	Rotenone
	Roundup	Organic	Glyphosate
S	Selenium	Inorganic	Selenium
	Settleable solids	Inorganic	Settleable solids
	Sevin	Organic	Carbaryl
	Silver	Inorganic	Silver
	Silvex	Organic	2,4,5-TP (Silvex)
	Simazine	Organic	Simazine
	Sinbar	Organic	Terbacil
	Sodium	Inorganic	Sodium
	Specific conductance	Inorganic	Specific conductance (EC)
	Spike	Organic	Tebuthiuron
	Strontium	Inorganic	Strontium
	Styrene	Organic	Styrene
	Sulfate	Inorganic	Sulfate
	Sutan	Organic	Butylate
	Systox	Organic	Demeton
T	2,4,5-T	Organic	2,4,5-T
	1,1,1-TCA	Organic	1,1,1-Trichloroethane
	1,1,2-TCA	Organic	1,1,2-Trichloroethane
	2,3,7,8-TCDD	Organic	2,3,7,8-TCDD (Dioxin)
	TCE	Organic	Trichloroethylene (TCE)
	TDE	Organic	DDD
	TDS	Inorganic	Total dissolved solids (TDS)
	Tebuthiuron	Organic	Tebuthiuron
	Telone	Organic	1,2-Dichloropropane 1,3-Dichloropropene Propanes, dichloro- Propenes, dichloro-
	Temik	Organic	Aldicarb
	Terbacil	Organic	Terbacil
	Terbufos	Organic	Terbufos
	Terraclor	Organic	Pentachloronitrobenzene
	1,2,4,5-Tetrachlorobenzene	Organic	1,2,4,5-Tetrachlorobenzene
	2,3,7,8-Tetrachlorodibenzo-p-dioxin	Organic	2,3,7,8-TCDD (Dioxin)
	1,1,1,2-Tetrachloroethane	Organic	1,1,1,2-Tetrachloroethane
	1,1,2,2-Tetrachloroethane	Organic	1,1,2,2-Tetrachloroethane
	Tetrachloroethene	Organic	Tetrachloroethylene (PCE)
	Tetrachloroethylene	Organic	Tetrachloroethylene (PCE)
	Tetrachloromethane	Organic	Carbon tetrachloride
	2,3,4,6-Tetrachlorophenol	Organic	2,3,4,6-Tetrachlorophenol

	CONSTITUENT	CATEGORY	SEE LISTING(S) UNDER:
	2,3,5,6-Tetrachlorophenol	Organic	2,3,5,6-Tetrachlorophenol
	Thallium	Inorganic	Thallium
	Thimet	Organic	Phorate
	Thiobencarb	Organic	Thiobencarb
	Thiodan	Organic	Endosulfan
	Thiophos	Organic	Parathion
	Thiram	Organic	Thiram
	THMs	Organic	Bromodichloromethane Bromoform Chloroform Dibromochloromethane
	TNT	Organic	Trinitrotoluene
	Toluene	Organic	Toluene
	Tordon	Organic	Picloram
	Total dissolved solids	Inorganic	Total dissolved solids (TDS)
	Toxaphene	Organic	Toxaphene
	2,4,5-TP	Organic	2,4,5-TP (Silvex)
	Treflan	Organic	Trifluralin
	Tribromomethane	Organic	Bromoform
	Tributyltin	Organic	Tributyltin
	Trichlorfon	Organic	Trichlorfon
	Trichloroacetaldehyde	Organic	Trichloroacetaldehyde
	Trichloroacetic acid	Organic	Trichloroacetic acid
	Trichloroacetonitrile	Organic	Trichloroacetonitrile
	1,2,4-Trichlorobenzene	Organic	1,2,4-Trichlorobenzene
	1,3,5-Trichlorobenzene	Organic	1,3,5-Trichlorobenzene
	Trichlorobenzenes	Organic	Benzenes, trichloro- 1,2,4-Trichlorobenzene 1,3,5-Trichlorobenzene
	1,1,1-Trichloroethane	Organic	1,1,1-Trichloroethane
	1,1,2-Trichloroethane	Organic	1,1,2-Trichloroethane
	Trichloroethene	Organic	Trichloroethylene (TCE)
	Trichloroethylene	Organic	Trichloroethylene (TCE)
	Trichlorofluoromethane	Organic	Trichlorofluoromethane
	Trichloromethane	Organic	Chloroform
	2,4,5-Trichlorophenol	Organic	2,4,5-Trichlorophenol
	2,4,6-Trichlorophenol	Organic	2,4,6-Trichlorophenol
	2,4,5-Trichlorophenoxyacetic acid	Organic	2,4,5-T
	2,4,5-Trichlorophenoxypropionic acid	Organic	2,4,5-TP (Silvex)
	1,2,3-Trichloropropane	Organic	1,2,3-Trichloropropane
	Trichlorotrifluoroethane	Organic	1,1,2-Trichloro-1,2,2-trifluoroethane
	1,1,2-Trichloro-1,2,2-trifluoroethane	Organic	1,1,2-Trichloro-1,2,2-trifluoroethane
	Trichlorphon	Organic	Trichlorfon
	Trifluralin	Organic	Trifluralin
	Trihalomethane(s)	Organic	Bromodichloromethane Bromoform Chloroform Dibromochloromethane
	Trinitroglycerol	Organic	Trinitroglycerol
	Trinitrophenol	Organic	Trinitrophenol
	Trinitrotoluene	Organic	Trinitrotoluene (TNT)
	Trithion	Organic	Trithion
	Turbacil	Organic	Terbacil
U	Uranium	Inorganic	Uranium
	Urethane	Organic	Urethane
	Urox	Organic	Bromacil
V	Vanadium	Inorganic	Vanadium
	VC	Organic	Vinyl chloride
	Vegadex	Organic	Sulfallate
	Velpar	Organic	Hexazinone
	Vinylbenzene	Organic	Styrene
	Vinyl chloride	Organic	Vinyl chloride
	Vinylidene chloride	Organic	1,1-Dichloroethylene
	Vitavax	Organic	Carboxin
	Vydate	Organic	Oxamyl
X	Xylene	Organic	Xylene(s)
	meta-Xylene	Organic	Xylene(s)
	ortho-Xylene	Organic	Xylene(s)
	para-Xylene	Organic	Xylene(s)
	Xylenes	Organic	Xylene(s)
	as-m-Xylenol	Organic	2,4-Dimethylphenol
Z	Zinc	Inorganic	Zinc
	Zineb	Organic	Zineb
	Ziram	Organic	Ziram

WATER QUALITY GOALS — INORGANIC CONSTITUENTS
HUMAN HEALTH AND WELFARE

INORGANIC CONSTITUENT	Drinking Water Standards (California & Federal) Maximum Contaminant Levels (MCLs)					California State Action Levels Department of Health Services		Health Advisories or Suggested No-Adverse-Response Levels (SNARLs) (also see cancer risk estimates)		California Proposition 65 Regulatory Level as a Water Quality Criterion (14)	One-in-a-Million Incremental Cancer Risk Estimates		
	California Dept. of Health Services		U. S. Environmental Protection Agency								U.S.EPA National Ambient Water Quality Criteria	U.S. EPA Health or Water Quality Advisories	National Academy of Sciences (NAS)
	Primary MCL	Secondary MCL	Primary MCL	Secondary MCL	MCL Goal	Toxicity	Taste & Odor	EPA	NAS				
Alkalinity													
Aluminum	1000			50 to 200 (93)					5000 (7-day)				
Ammonia								30,000 (68)				(D)	
Ammonium sulfamate								2000				(D)	
Antimony			5 to 10 (100)		3 (100)			3 (68)				(D)	
Arsenic	50		50		zero (100)					0.3(102) / 5	0.0022	0.03 (A,68)	
Asbestos			(93,101)		(93,101)					(15)	30,000 fibers/l	(101,A)	
Barium	1000		1000 / 2000(107)		2000(107)			2000	4700			(D)	
Beryllium			1 (100)		zero (100)			4000 / 20,000 (7-yr,7,68)		(15)	0.0068	0.008 (B2,68)	
Boron								600 (68)				(D)	
Bromide									2300				
Cadmium	10		10 / 5(93)		5 (93)			5	5	(15)		(D)	
Chloramine								300 (68)	166 / 581 (7)			(D)	
Chlorate								10 (68)	7 / 24 (7)			(D)	
Chloride		250,000 (73)		250,000									
Chlorine								1000 (68)				(D)	
Chlorine dioxide								80 (68)	60 / 210 (7)			(D)	
Chlorite								30 (68)	7 / 24 (7)				
Chromium (total)	50		50 / 100(93)		100 (93)			100				(D)	
Chromium (III)													
Chromium (VI)										(15)		(A)	
Cobalt													
Color		15 units		15 units									
Copper		1000	1300 (111)	1000	1300 (116)							(D)	
Cyanide			200 (100)		200 (100)			200				(D)	
Fluoride	1400 to 2400 (109)		4000	2000	4000							(D)	
Foaming agents (MBAS)		500		500									
Hardness													
Hydrazine										0.02 (100)			
Hydrazine sulfate										0.1 (100)			
Hydrogen sulfide													
Iodide									1190				
Iron		300		300									
Lead	50		50 / 15(111)		zero (116)					0.25 (5)		(B2)	
Manganese		50		50									
Mercury	2		2		2			2				(D)	
Molybdenum								50 (68)				(D)	
Nickel			100 (100)		100 (100)			100		(15)		(D)	
Nitrate	45,000 (72)		10,000 (103)		10,000 (93,103)			10,000 (10-day,89)				(D)	
Nitrite			1000 (93,103)		1000 (93,103)			1000 (10-day,89)				(D)	
Oxygen, dissolved													
pH				6.5 to 8.5 pH units									
Phosphorus								0.1 (40,68)				(D)	
Radioactivity, Gross Alpha	15 pCi/l		15 pCi/l (110)		zero							(A)	
Radioactivity, Gross Beta	50 pCi/l		4 mrem/yr		zero							0.04 mrem/yr (A)	
Radium 226 + 228	5 pCi/l		5 pCi/l / 20 pCi/l(100)		zero							0.22 pCi/l (A)	
Radon			300 pCi/l (100)		zero (100)							1.6 pCi/l (A)	
Selenium	10		10 / 50(93)		10 / 50(93)								
Settleable solids													
Silver	50		50	100 (93)				100 (68)				(D)	
Sodium								2000 (57)					
Specific conductance (EC)		900 µmhos/cm(74)											
Strontium								17,000 (68)	8400 (7-day)			(D)	
Strontium-90	8 pCi/l											(A)	
Sulfate		250,000 (73)	400,000 (100)	250,000	400,000 (100)							(D)	
Thallium			1 to 2 (100)		0.5 (100)			0.4 (68)					
Total dissolved solids (TDS)		500,000 (75)		500,000									
Tritium	20,000 pCi/l											(A)	
Turbidity		5 units	1 to 5 units										
Uranium	20 pCi/l		20 µg/l = 30 pCi/l(100)		zero (100)				35			0.26 pCi/l (A)	
Vanadium								20 (68)				(D)	
Zinc		5000		5000				2000 (68)				(D)	

Values are in µg/l (ppb) unless otherwise indicated. Numbers in parentheses indicate footnotes.

WATER QUALITY GOALS — INORGANIC CONSTITUENTS
AGRICULTURAL USE, HEALTH & WELFARE, AND FRESHWATER AQUATIC LIFE

INORGANIC CONSTITUENT	Agricultural Water Quality Goals (78)	U. S. EPA National Ambient Water Quality Criteria: Health & Welfare Protection: Public Health Effects	Health & Welfare Protection: Taste & Odor or Welfare	Freshwater Aquatic Life Protection: Recommended Criteria: Continuous Concentration (4-day Average)	24-hour Average	Maximum Concentration (1-hour Average)	Maximum	Toxicity Information: Acute	Chronic	Other
Alkalinity							≥ 20,000 (114)			
Aluminum	5000			87 (62)		750 (62)				
Ammonia				See page 5 (97)		See page 5 (97)				
Ammonium sulfamate										
Antimony		146		30 (94,100)		88 (94,100)		9000	1600	610 (38)
Arsenic	100			190 (94)		360 (94)		850 (95)		48 (6)
Asbestos										
Barium		1000								
Beryllium	100							130	5.3	
Boron	700 / 750(26)									
Bromide										
Cadmium	10	10		0.55 (2,10) see p. 7		1.4 (2,33) see p. 7				
Chloramine										
Chlorate										
Chloride	106,000	250,000		230,000 (4)		860,000 (4)				
Chlorine				11 (98)		19 (98)				
Chlorine dioxide										
Chlorite										
Chromium (total)										
Chromium (III)		170,000		98 (2,55) see p. 7		820 (2,60) see p. 7				
Chromium (VI)	100	50		11		16				
Cobalt	50									
Color										
Copper	200		1000	5.4 (2,63) see p. 7		7.5 (2,65) see p. 7				
Cyanide		200		5.2		22				
Fluoride	1000									
Foaming agents (MBAS)										
Hardness										
Hydrazine										
Hydrazine sulfate										
Hydrogen sulfide							2			
Iodide										
Iron	5000		300				1000			
Lead	5000	50		0.99 (2,66) see p. 7		25 (2,67) see p. 7				
Manganese	200		50							
Mercury		0.144		0.012		2.4				
Molybdenum	10									
Nickel	200	13.4		73 (2,81) see p. 7		653 (2,85) see p. 7				
Nitrate		10,000 (89)								
Nitrite										
Oxygen, dissolved				(91)	(91)					
pH			5 - 9 pH units				6.5 - 9.0 pH units			
Phosphorus										
Radioactivity, Gross Alpha										
Radioactivity, Gross Beta										
Radium 226 + 228										
Radon										
Selenium	20	10		5		20				
Settleable solids										
Silver		50		0.12 (100)		0.92 (100)	0.84 (2,49) see p. 7		0.12	
Sodium										
Specific conductance (EC)	700 µmhos/cm									
Strontium										
Strontium-90										
Sulfate			250,000							
Thallium		13						1400	40	20 (16)
Total dissolved solids (TDS)	450,000									
Tritium										
Turbidity										
Uranium										
Vanadium	100									
Zinc	2000		5000	49 (2,9) see p. 7		54 (1,2) see p. 7				

Values are in µg/l (ppb) unless otherwise indicated. Numbers in parentheses indicate footnotes.

WATER QUALITY GOALS — INORGANIC CONSTITUENTS
HEALTH AND AQUATIC LIFE — INLAND SURFACE WATERS AND ENCLOSED BAYS & ESTUARIES

INORGANIC CONSTITUENT	California Inland Surface Waters Plan Numerical Water Quality Objectives						California Enclosed Bays & Estuaries Plan Numerical Water Quality Objectives			
	Human Health Protection (30-day Average) "‡" = carcinogen		Freshwater Aquatic Life Protection				Human Health Protection (30-day Average) "‡" = carcinogen	Saltwater Aquatic Life Protection		
	Sources of Drinking Water	Other Waters	4-day Average	Daily Average	1-hour Average	Instantaneous Maximum		4-day Average	Daily Average	1-hour Average
Alkalinity										
Aluminum										
Ammonia										
Ammonium sulfamate										
Antimony										
Arsenic	5.0 ‡		190		360			36		69
Asbestos										
Barium										
Beryllium										
Boron										
Bromide										
Cadmium	10		0.55 (2,10) see p. 7		1.4 (2,33) see p. 7			9.3		43
Chloramine										
Chlorate										
Chloride										
Chlorine										
Chlorine dioxide										
Chlorite										
Chromium (total)	50 (12)		11 (12)		16 (12)			50 (12)		1100 (12)
Chromium (III)										
Chromium (VI)	50 (12)		11 (12)		16 (12)			50 (12)		1100 (12)
Cobalt										
Color										
Copper	1000 (36)		5.4 (2,63) see p. 7		7.5 (2,65) see p. 7					2.9
Cyanide										
Fluoride										
Foaming agents (MBAS)										
Hardness										
Hydrazine										
Hydrazine sulfate										
Hydrogen sulfide										
Iodide										
Iron										
Lead	50		0.99 (2,66) see p. 7		25 (2,67) see p. 7			5.6		140
Manganese										
Mercury	0.012	0.012			2.4		0.025			2.1
Molybdenum										
Nickel	600	4600	73 (2,81) see p. 7		653 (2,85) see p. 7		4600	8.3		75
Nitrate										
Nitrite										
Oxygen, dissolved										
pH										
Phosphorus										
Radioactivity, Gross Alpha										
Radioactivity, Gross Beta										
Radium 226 + 228										
Radon										
Selenium	10		5.0		20			71		300
Settleable solids										
Silver	50					0.84 (2,49) see p. 7				2.3 (80)
Sodium										
Specific conductance (EC)										
Strontium										
Strontium-90										
Sulfate										
Thallium										
Total dissolved solids (TDS)										
Tritium										
Turbidity										
Uranium										
Vanadium										
Zinc	5000 (36)		49 (2,9) see p. 7		54 (1,2) see p. 7			86		95

Values are in µg/l (ppb) unless otherwise indicated. Numbers in parentheses indicate footnotes.

WATER QUALITY GOALS — INORGANIC CONSTITUENTS
MARINE RESOURCES

INORGANIC CONSTITUENT	California Ocean Plan Numerical Water Quality Objectives						U. S. EPA National Ambient Water Quality Criteria Saltwater Aquatic Life Protection						
	Human Health Protection (30-day Average) "‡" = carcinogen	Marine Aquatic Life Protection					Recommended Criteria				Toxicity Information		
		6-month Median	30-day Average	7-day Average	Daily Maximum	Instantaneous Maximum	Continuous Concentration (4-day Average)	24-hour Average	Maximum Concentration (1-hour Average)	Maximum	Acute	Chronic	Other
Alkalinity													
Aluminum													
Ammonia		600 (89)			2400 (89)	6000 (89)	35 (112) see p. 6		233 (112) see p. 6				
Ammonium sulfamate													
Antimony	1200						500 (94,100)		1500 (94,100)				
Arsenic		8			32	80	36 (94)		69 (94)		2319 (95)		13 (6)
Asbestos													
Barium													
Beryllium	0.033 ‡												
Boron													
Bromide													
Cadmium		1			4	10	9.3		43				
Chloramine													
Chlorate													
Chloride													
Chlorine		2 (90)			8 (90)	60 (90)	7.5 (99)		13 (99)				
Chlorine dioxide													
Chlorite													
Chromium (total)		2 (12)			8 (12)	20 (12)							
Chromium (III)	190,000										10,300 (96)		
Chromium (VI)		2 (12)			8 (12)	20 (12)	50		1100				
Cobalt													
Color													
Copper		3			12	30			2.9				
Cyanide		1			4	10			1				
Fluoride													
Foaming agents (MBAS)													
Hardness													
Hydrazine													
Hydrazine sulfate													
Hydrogen sulfide										2			
Iodide													
Iron													
Lead		2			8	20	5.6		140				
Manganese										100			
Mercury		0.04			0.16	0.4	0.025		2.1				
Molybdenum													
Nickel		5			20	50	8.3		75				
Nitrate													
Nitrite													
Oxygen, dissolved													
pH						6.0-9.0 pH units				6.5 - 8.5 pH units			
Phosphorus										0.1 (79)			
Radioactivity, Gross Alpha						15 pCi/l (110)							
Radioactivity, Gross Beta						50 pCi/l							
Radium 226 + 228						5 pCi/l							
Radon													
Selenium		15			60	150	71		300				
Settleable solids			1000	1500		3000							
Silver		0.7			2.8	7	0.92 (100)		7.2 (100)	2.3			
Sodium													
Specific conductance (EC)													
Strontium													
Strontium-90						8 pCi/l							
Sulfate													
Thallium	14										2130		
Total dissolved solids (TDS)													
Tritium						20,000 pCi/l							
Turbidity			75 NTU	100 NTU		225 NTU							
Uranium						20 pCi/l							
Vanadium													
Zinc		20			80	200	86		95				

Values are in µg/l (ppb) unless otherwise indicated. Numbers in parentheses indicate footnotes.

WATER QUALITY GOALS — INORGANIC CONSTITUENTS
FRESHWATER AQUATIC LIFE — AMMONIA

U.S. EPA National Ambient Water Quality Criteria to protect Freshwater Aquatic Life — Criteria Continuous Concentrations (4-day Avg.) for Ammonia at these Temperatures (°C)

pH	0	5	10	15	20	25	30
Salmonids or Other Sensitive Coldwater Species Present —							
	Un-ionized Ammonia (mg/l as NH3‡)						
6.50	0.0007	0.0009	0.0013	0.0019	0.0019	0.0019	0.0019
6.75	0.0012	0.0017	0.0023	0.0033	0.0033	0.0033	0.0033
7.00	0.0021	0.0029	0.0042	0.0059	0.0059	0.0059	0.0059
7.25	0.0037	0.0052	0.0074	0.0105	0.0105	0.0105	0.0105
7.50	0.0066	0.0093	0.0132	0.0186	0.0186	0.0186	0.0186
7.75	0.0109	0.0153	0.022	0.031	0.031	0.031	0.031
8.00	0.0126	0.0177	0.025	0.035	0.035	0.035	0.035
8.25	0.0126	0.0177	0.025	0.035	0.035	0.035	0.035
8.50	0.0126	0.0177	0.025	0.035	0.035	0.035	0.035
8.75	0.0126	0.0177	0.025	0.035	0.035	0.035	0.035
9.00	0.0126	0.0177	0.025	0.035	0.035	0.035	0.035
	Total Ammonia (mg/l as NH3‡)						
6.50	2.5	2.4	2.2	2.2	1.49	1.04	0.73
6.75	2.5	2.4	2.2	2.2	1.49	1.04	0.73
7.00	2.5	2.4	2.2	2.2	1.49	1.04	0.74
7.25	2.5	2.4	2.2	2.2	1.50	1.04	0.74
7.50	2.5	2.4	2.2	2.2	1.50	1.05	0.74
7.75	2.3	2.2	2.1	2.0	1.40	0.99	0.71
8.00	1.53	1.44	1.37	1.33	0.93	0.66	0.47
8.25	0.87	0.82	0.78	0.76	0.54	0.39	0.28
8.50	0.49	0.47	0.45	0.44	0.32	0.23	0.17
8.75	0.28	0.27	0.26	0.27	0.19	0.15	0.11
9.00	0.16	0.16	0.16	0.16	0.13	0.10	0.08
Salmonids or Other Sensitive Coldwater Species Absent † —							
	Un-ionized Ammonia (mg/l as NH3‡)						
6.50	0.0007	0.0009	0.0013	0.0019	0.0026	0.0026	0.0026
6.75	0.0012	0.0017	0.0023	0.0033	0.0047	0.0047	0.0047
7.00	0.0021	0.0029	0.0042	0.0059	0.0083	0.0083	0.0083
7.25	0.0037	0.0052	0.0074	0.0105	0.0148	0.0148	0.0148
7.50	0.0066	0.0093	0.0132	0.0186	0.026	0.026	0.026
7.75	0.0109	0.0153	0.022	0.031	0.043	0.043	0.043
8.00	0.0126	0.0177	0.025	0.035	0.050	0.050	0.050
8.25	0.0126	0.0177	0.025	0.035	0.050	0.050	0.050
8.50	0.0126	0.0177	0.025	0.035	0.050	0.050	0.050
8.75	0.0126	0.0177	0.025	0.035	0.050	0.050	0.050
9.00	0.0126	0.0177	0.025	0.035	0.050	0.050	0.050
	Total Ammonia (mg/l as NH3‡)						
6.50	2.5	2.4	2.2	2.2	2.1	1.46	1.03
6.75	2.5	2.4	2.2	2.2	2.1	1.47	1.04
7.00	2.5	2.4	2.2	2.2	2.1	1.47	1.04
7.25	2.5	2.4	2.2	2.2	2.1	1.48	1.05
7.50	2.5	2.4	2.2	2.2	2.1	1.49	1.06
7.75	2.3	2.2	2.1	2.0	1.98	1.39	1.00
8.00	1.53	1.44	1.37	1.33	1.31	0.93	0.67
8.25	0.87	0.82	0.78	0.76	0.76	0.54	0.40
8.50	0.49	0.47	0.45	0.44	0.45	0.33	0.25
8.75	0.28	0.27	0.26	0.27	0.27	0.21	0.16
9.00	0.16	0.16	0.16	0.16	0.17	0.14	0.11

U.S. EPA National Ambient Water Quality Criteria to protect Freshwater Aquatic Life — Criteria Maximum Concentrations (1-hour Avg.) for Ammonia at these Temperatures (°C)

pH	0	5	10	15	20	25	30
Salmonids or Other Sensitive Coldwater Species Present —							
	Un-ionized Ammonia (mg/l as NH3‡)						
6.50	0.0091	0.0129	0.0182	0.026	0.036	0.036	0.036
6.75	0.0149	0.021	0.030	0.042	0.059	0.059	0.059
7.00	0.023	0.033	0.046	0.066	0.093	0.093	0.093
7.25	0.034	0.048	0.068	0.095	0.135	0.135	0.135
7.50	0.045	0.064	0.091	0.128	0.181	0.181	0.181
7.75	0.056	0.080	0.113	0.159	0.22	0.22	0.22
8.00	0.065	0.092	0.130	0.184	0.26	0.26	0.26
8.25	0.065	0.092	0.130	0.184	0.26	0.26	0.26
8.50	0.065	0.092	0.130	0.184	0.26	0.26	0.26
8.75	0.065	0.092	0.130	0.184	0.26	0.26	0.26
9.00	0.065	0.092	0.130	0.184	0.26	0.26	0.26
	Total Ammonia (mg/l as NH3‡)						
6.50	35	33	31	30	29	20	14.3
6.75	32	30	28	27	27	18.6	13.2
7.00	28	26	25	24	23	16.4	11.6
7.25	23	22	20	19.7	19.2	13.4	9.5
7.50	17.4	16.3	15.5	14.9	14.6	10.2	7.3
7.75	12.2	11.4	10.9	10.5	10.3	7.2	5.2
8.00	8.0	7.5	7.1	6.9	6.8	4.8	3.5
8.25	4.5	4.2	4.1	4.0	3.9	2.8	2.1
8.50	2.6	2.4	2.3	2.3	2.3	1.71	1.28
8.75	1.47	1.4	1.37	1.38	1.42	1.07	0.83
9.00	0.86	0.83	0.83	0.86	0.91	0.72	0.58
Salmonids or Other Sensitive Coldwater Species Absent —							
	Un-ionized Ammonia (mg/l as NH3‡)						
6.50	0.0091	0.0129	0.0182	0.026	0.036	0.051	0.051
6.75	0.0149	0.021	0.030	0.042	0.059	0.084	0.084
7.00	0.023	0.033	0.046	0.066	0.093	0.131	0.131
7.25	0.034	0.048	0.068	0.095	0.135	0.190	0.190
7.50	0.045	0.064	0.091	0.128	0.181	0.26	0.26
7.75	0.056	0.080	0.113	0.159	0.22	0.32	0.32
8.00	0.065	0.092	0.130	0.184	0.26	0.37	0.37
8.25	0.065	0.092	0.130	0.184	0.26	0.37	0.37
8.50	0.065	0.092	0.130	0.184	0.26	0.37	0.37
8.75	0.065	0.092	0.130	0.184	0.26	0.37	0.37
9.00	0.065	0.092	0.130	0.184	0.26	0.37	0.37
	Total Ammonia (mg/l as NH3‡)						
6.50	35	33	31	30	29	29	20
6.75	32	30	28	27	27	26	18.6
7.00	28	26	25	24	23	23	16.4
7.25	23	22	20	19.7	19.2	19.0	13.5
7.50	17.4	16.3	15.5	14.9	14.6	14.5	10.3
7.75	12.2	11.4	10.9	10.5	10.3	10.2	7.3
8.00	8.0	7.5	7.1	6.9	6.8	6.8	4.9
8.25	4.5	4.2	4.1	4.0	3.9	4.0	2.9
8.50	2.6	2.4	2.3	2.3	2.3	2.4	1.81
8.75	1.47	1.40	1.37	1.38	1.42	1.52	1.18
9.00	0.86	0.83	0.83	0.86	0.91	1.01	0.82

‡ To convert these values to mg/l as N, multiply by 0.822.

† Site-specific criteria development is strolnly suggested at temperatures above 20° C because of the limited data available to generate the criteria recommendation, and at temperatures below 20° C because small changes in the criteria may have significant impact on the level of treatment required in meeting the recommended criteria.

From Reference 13.

WATER QUALITY GOALS – INORGANIC CONSTITUENTS
SALTWATER AQUATIC LIFE — AMMONIA

U. S. EPA National Ambient Water Quality Criteria to protect Saltwater Aquatic Life
Criteria Continuous Concentrations (4-day Avg.) for Total Ammonia at these Temperatures (°C)

pH	0	5	10	15	20	25	30	35
	Salinity = 10 g/kg							
7.0	41	29	20	14	9.4	6.6	4.4	3.1
7.2	26	18	12	8.7	5.9	4.1	2.8	2.0
7.4	17	12	7.8	5.3	3.7	2.6	1.8	1.2
7.6	10	7.2	5.0	3.4	2.4	1.7	1.2	0.84
7.8	6.6	4.7	3.1	2.2	1.5	1.1	0.75	0.53
8.0	4.1	2.9	2.0	1.40	0.97	0.69	0.47	0.34
8.2	2.7	1.8	1.3	0.87	0.62	0.44	0.31	0.23
8.4	1.7	1.2	0.81	0.56	0.41	0.29	0.21	0.16
8.6	1.1	0.75	0.53	0.37	0.27	0.20	0.15	0.11
8.8	0.69	0.50	0.34	0.25	0.18	0.14	0.11	0.08
9.0	0.44	0.31	0.23	0.17	0.13	0.10	0.08	0.07
	Salinity = 20 g/kg							
7.0	44	30	21	14	9.7	6.6	4.7	3.1
7.2	27	19	13	9.0	6.2	4.4	3.0	2.1
7.4	18	12	8.1	5.6	4.1	2.7	1.9	1.3
7.6	11	7.5	5.3	3.4	2.5	1.7	1.2	0.84
7.8	6.9	4.7	3.4	2.3	1.6	1.1	0.78	0.53
8.0	4.4	3.0	2.1	1.5	1.0	0.72	0.50	0.34
8.2	2.8	1.9	1.3	0.94	0.66	0.47	0.31	0.24
8.4	1.8	1.2	0.84	0.59	0.44	0.30	0.22	0.16
8.6	1.1	0.78	0.56	0.41	0.28	0.20	0.15	0.12
8.8	0.72	0.50	0.37	0.26	0.19	0.14	0.11	0.08
9.0	0.47	0.34	0.24	0.18	0.13	0.10	0.08	0.07
	Salinity = 30 g/kg							
7.0	47	31	22	15	11	7.2	5.0	3.4
7.2	29	20	14	9.7	6.6	4.7	3.1	2.2
7.4	19	13	8.7	5.6	4.1	2.9	2.0	1.4
7.6	12	8.1	5.6	3.7	3.1	1.8	1.3	0.90
7.8	7.5	5.0	3.4	2.4	1.7	1.2	0.81	0.56
8.0	4.7	3.1	2.2	1.6	1.1	0.75	0.53	0.37
8.2	3.0	2.1	1.4	1.0	0.69	0.50	0.34	0.25
8.4	1.9	1.3	0.90	0.62	0.44	0.31	0.23	0.17
8.6	1.2	0.84	0.59	0.41	0.30	0.22	0.16	0.12
8.8	0.78	0.53	0.37	0.27	0.20	0.15	0.11	0.09
9.0	0.50	0.34	0.26	0.19	0.14	0.11	0.08	0.07

U. S. EPA National Ambient Water Quality Criteria to protect Saltwater Aquatic Life
Criteria Maximum Concentrations (1-hour Avg.) for Total Ammonia at these Temperatures (°C)

pH	0	5	10	15	20	25	30	35
	Salinity = 10 g/kg							
7.0	270	191	131	92	62	44	29	21
7.2	175	121	83	58	40	27	19	13
7.4	110	77	52	35	25	14	12	8.3
7.6	69	48	33	23	16	11	7.7	5.6
7.8	44	31	21	15	10	7.1	5.0	3.5
8.0	27	19	13	9.4	6.4	4.6	3.1	2.3
8.2	18	12	8.5	5.8	4.2	2.9	2.1	1.5
8.4	11	7.9	5.4	3.7	2.7	1.9	1.4	1.0
8.6	7.3	5.0	3.5	2.5	1.8	1.3	0.98	0.75
8.8	4.6	3.3	2.3	1.7	1.2	0.92	0.71	0.56
9.0	2.9	2.[illegible]	1.5	1.1	0.85	0.67	0.52	0.44
	Salinity = 20 g/kg							
7.0	291	200	137	96	64	44	31	21
7.2	183	125	87	60	42	29	20	14
7.4	116	79	54	37	27	18	12	8.7
7.6	73	50	35	23	17	11	7.9	5.6
7.8	46	31	23	15	11	7.5	5.2	3.5
8.0	29	20	14	9.8	6.7	4.8	3.3	2.3
8.2	19	13	8.9	6.2	4.4	3.1	2.1	1.6
8.4	12	8.1	5.6	4.0	2.9	2.0	1.5	1.1
8.6	7.5	5.2	3.7	2.7	1.9	1.4	1.0	0.77
8.8	4.8	3.3	2.5	1.7	1.3	0.94	0.73	0.56
9.0	3.1	2.3	1.6	1.2	0.87	0.69	0.54	0.44
	Salinity = 30 g/kg							
7.0	312	208	148	102	71	48	33	23
7.2	196	135	94	64	44	31	21	15
7.4	125	85	58	40	27	19	13	9.4
7.6	79	54	37	25	21	12	8.5	6.0
7.8	50	33	23	16	11	7.9	5.4	3.7
8.0	31	21	15	10	7.3	5.0	3.5	2.5
8.2	20	14	9.6	6.7	4.6	3.3	2.3	1.7
8.4	12.7	8.7	6.0	4.2	2.9	2.1	1.6	1.1
8.6	8.1	5.6	4.0	2.7	2.0	1.4	1.1	0.81
8.8	5.2	3.5	2.5	1.8	1.3	1.0	0.75	0.58
9.0	3.3	2.3	1.7	1.2	0.94	0.71	0.56	0.46

From Reference 13.

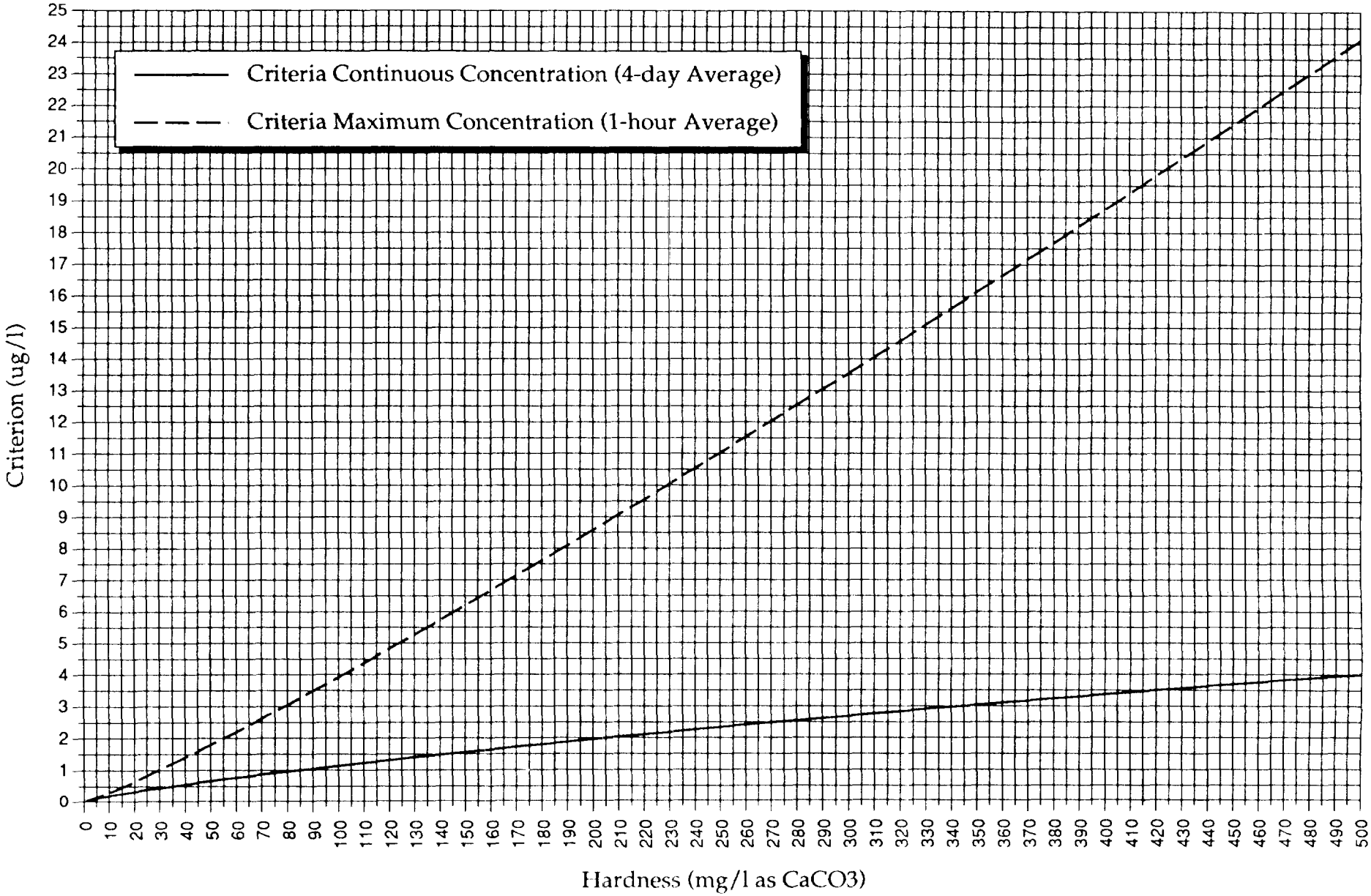
WATER QUALITY GOALS — INORGANIC CONSTITUENTS

FRESHWATER AQUATIC LIFE — METALS

Hardness (mg/l as CaCO3)	U.S. EPA National Ambient Water Quality Criteria to Protect Freshwater Aquatic Life												
	Cadmium Continuous Conc. 4-day Avg. (µg/l)	Cadmium Maximum Conc. 1-hour Avg. (µg/l)	Chromium III Continuous Conc. 4-day Avg. (µg/l)	Chromium III Maximum Conc. 1-hour Avg. (µg/l)	Copper Continuous Conc. 4-day Avg. (µg/l)	Copper Maximum Conc. 1-hour Avg. (µg/l)	Lead Continuous Conc. 4-day Avg. (µg/l)	Lead Maximum Conc. 1-hour Avg. (µg/l)	Nickel Continuous Conc. 4-day Avg. (µg/l)	Nickel Maximum Conc. 1-hour Avg. (µg/l)	Silver Maximum Conc. at any time (µg/l)	Zinc Continuous Conc. 4-day Avg. (µg/l)	Zinc Maximum Conc. 1-hour Avg. (µg/l)
5	0.11	0.13	18	149	0.91	1.1	0.070	1.8	13	112	0.023	8.4	9.2
10	0.19	0.29	31	263	1.7	2.0	0.17	4.4	22	202	0.077	15	17
15	0.26	0.46	44	367	2.3	3.0	0.28	7.3	32	285	0.16	21	23
20	0.32	0.64	55	465	3.0	3.9	0.41	11	40	363	0.25	27	30
25	0.38	0.82	67	558	3.6	4.8	0.54	14	49	439	0.37	33	36
30	0.44	1.0	77	648	4.2	5.7	0.69	18	57	512	0.51	38	42
35	0.50	1.2	88	735	4.8	6.6	0.84	21	65	583	0.67	44	48
40	0.55	1.4	98	820	5.4	7.5	0.99	25	73	653	0.84	49	54
45	0.61	1.6	108	903	6.0	8.4	1.2	30	80	722	1.0	54	59
50	0.66	1.8	117	984	6.5	9.2	1.3	34	88	789	1.2	59	65
55	0.71	2.0	127	1064	7.1	10	1.5	38	95	855	1.5	64	71
60	0.76	2.2	136	1143	7.6	11	1.7	43	102	921	1.7	69	76
65	0.81	2.4	145	1220	8.2	12	1.8	47	110	985	1.9	74	81
70	0.86	2.6	155	1297	8.7	13	2.0	52	117	1049	2.2	78	87
75	0.90	2.8	164	1372	9.2	14	2.2	57	124	1112	2.5	83	92
80	0.95	3.0	172	1446	9.8	14	2.4	61	131	1174	2.8	88	97
85	1.0	3.3	181	1520	10	15	2.6	66	137	1236	3.1	92	102
90	1.0	3.5	190	1593	11	16	2.8	71	144	1297	3.4	97	107
95	1.1	3.7	198	1665	11	17	3.0	76	151	1358	3.7	101	112
100	1.1	3.9	207	1737	12	18	3.2	82	158	1418	4.1	106	117
110	1.2	4.4	224	1877	13	19	3.6	92	171	1537	4.8	115	127
120	1.3	4.8	240	2016	14	21	4.0	103	184	1655	5.6	124	137
130	1.4	5.3	257	2153	15	23	4.4	114	197	1771	6.4	132	148
140	1.5	5.7	273	2287	16	24	4.9	125	210	1885	7.2	141	156
150	1.6	6.2	289	2420	17	26	5.3	137	222	1999	8.2	149	165
160	1.6	6.7	304	2552	18	28	5.8	149	235	2111	9.1	158	174
170	1.7	7.1	320	2682	19	29	6.3	160	247	2222	10	166	183
180	1.8	7.6	335	2810	20	31	6.7	173	259	2332	11	174	193
190	1.9	8.1	350	2937	20	32	7.2	185	271	2441	12	183	202
200	2.0	8.6	365	3064	21	34	7.7	197	283	2549	13	191	211
210	2.0	9.1	380	3188	22	36	8.2	210	295	2657	15	199	219
220	2.1	9.5	395	3312	23	37	8.7	223	307	2763	16	207	228
230	2.2	10	409	3435	24	39	9.2	236	319	2869	17	215	237
240	2.3	11	424	3557	25	40	9.7	249	331	2974	18	223	246
250	2.3	11	438	3678	26	42	10	262	342	3079	20	230	254
260	2.4	12	453	3798	27	44	11	276	354	3183	21	238	263
270	2.5	12	467	3917	28	45	11	289	365	3286	22	246	271
280	2.5	13	481	4036	29	47	12	303	377	3389	24	254	280
290	2.6	13	495	4153	29	48	12	317	388	3491	25	261	288
300	2.7	14	509	4270	30	50	13	331	399	3592	27	269	297
310	2.8	14	523	4386	31	51	13	345	411	3694	28	276	305
320	2.8	15	537	4502	32	53	14	359	422	3794	30	284	314
330	2.9	15	550	4617	33	55	15	373	433	3894	32	291	322
340	3.0	16	564	4731	34	56	15	388	444	3994	33	299	330
350	3.0	16	577	4845	34	58	16	402	455	4093	35	306	338
360	3.1	17	591	4958	35	59	16	417	466	4192	37	314	346
370	3.2	17	604	5070	36	61	17	432	477	4290	39	321	355
380	3.2	18	618	5182	37	62	17	447	488	4388	40	328	363
390	3.3	18	631	5294	38	64	18	462	499	4485	42	336	371
400	3.4	19	644	5405	39	65	19	477	509	4582	44	343	379
410	3.4	19	657	5515	39	67	19	492	520	4679	46	350	387
420	3.5	20	670	5625	40	69	20	507	531	4776	48	358	395
430	3.6	20	684	5734	41	70	20	523	542	4872	50	365	403
440	3.6	21	697	5843	42	72	21	538	552	4967	52	372	411
450	3.7	21	709	5952	43	73	22	554	563	5063	54	379	419
460	3.8	22	722	6060	44	75	22	570	573	5158	56	386	426
470	3.8	22	735	6168	44	76	23	585	584	5252	58	393	434
480	3.9	23	748	6275	45	78	23	601	594	5347	60	400	442
490	4.0	24	761	6382	46	79	24	617	605	5441	62	407	450
500	4.0	24	773	6488	47	81	25	633	615	5535	65	414	458

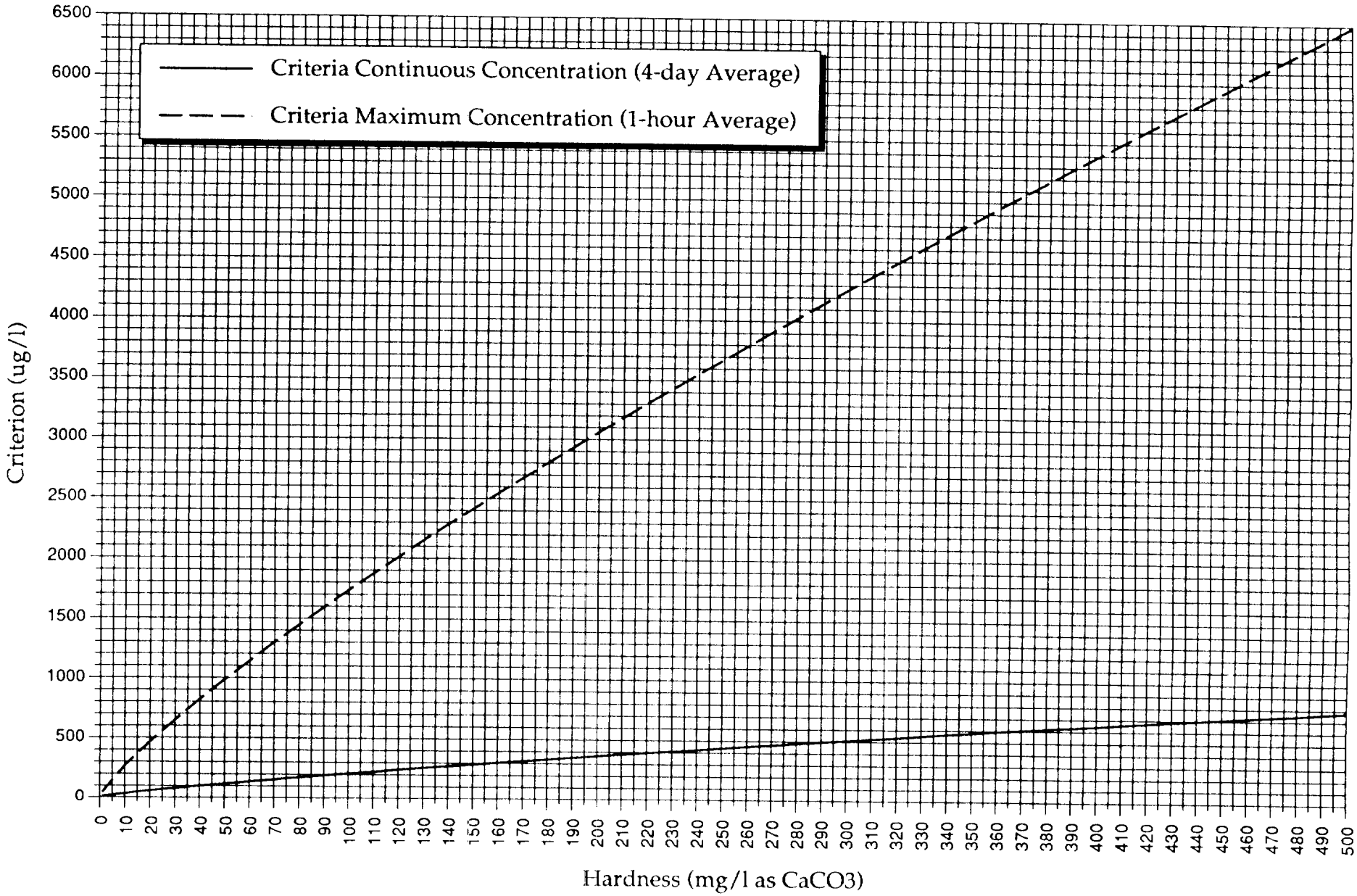
From Reference 13. These criteria functions are graphed on pages 8 through 14.

NATIONAL AMBIENT WATER QUALITY CRITERIA TO PROTECT FRESHWATER AQUATIC LIFE — CADMIUM



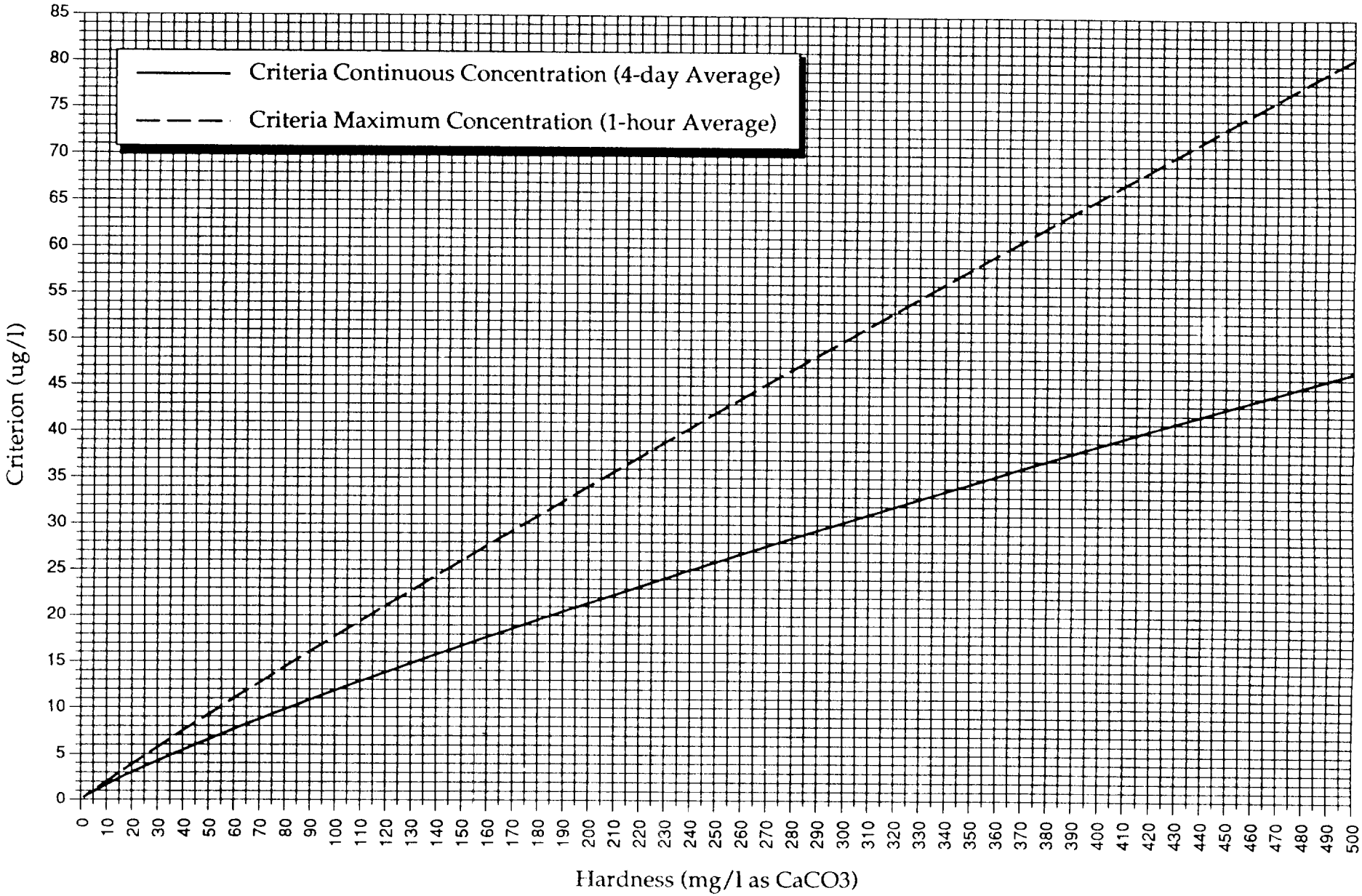
From Reference 13. These data are tabulated on page 7.

NATIONAL AMBIENT WATER QUALITY CRITERIA TO PROTECT FRESHWATER AQUATIC LIFE — CHROMIUM III



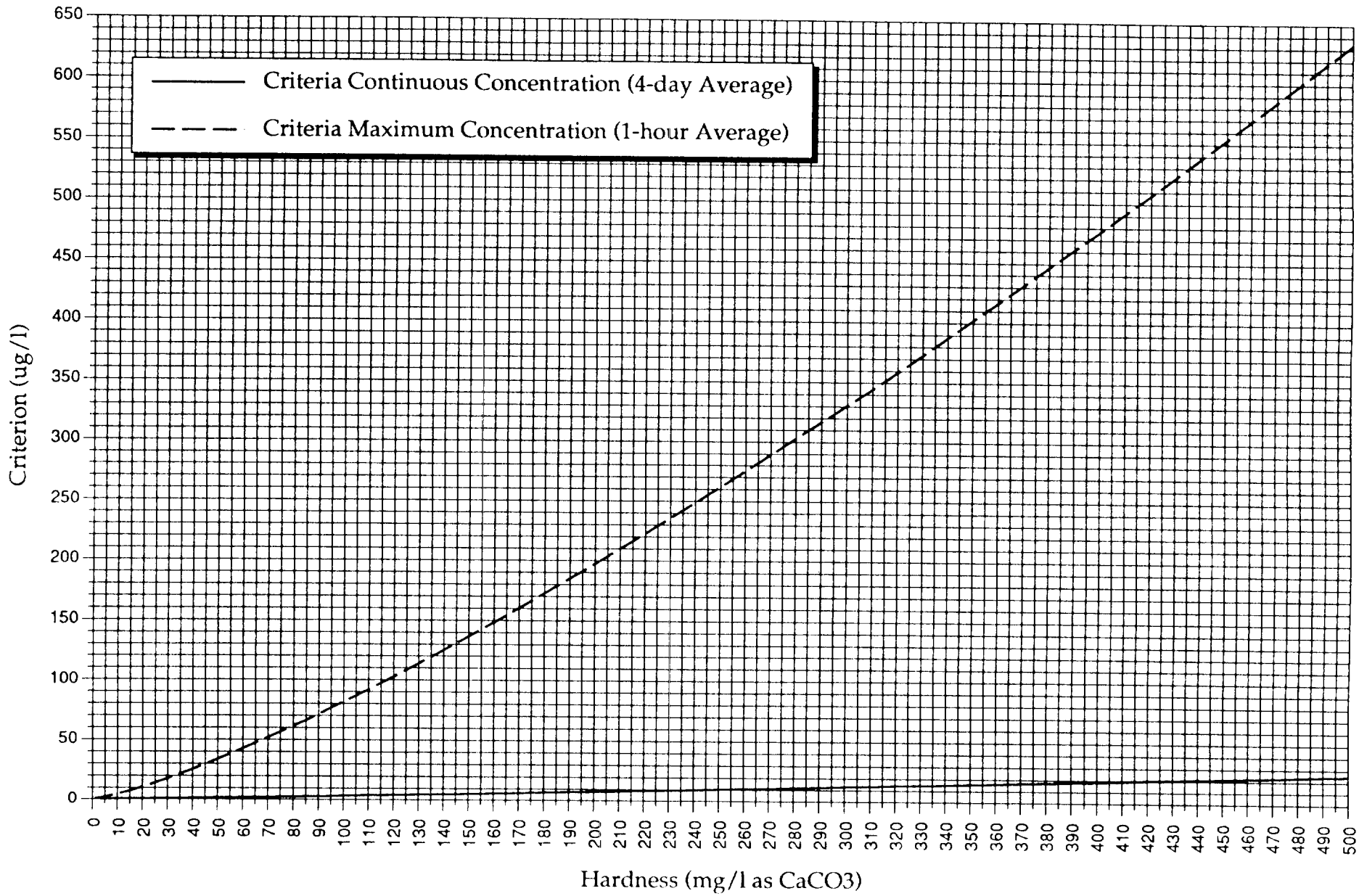
From Reference 13. These data are tabulated on page 7.

NATIONAL AMBIENT WATER QUALITY CRITERIA TO PROTECT FRESHWATER AQUATIC LIFE — COPPER



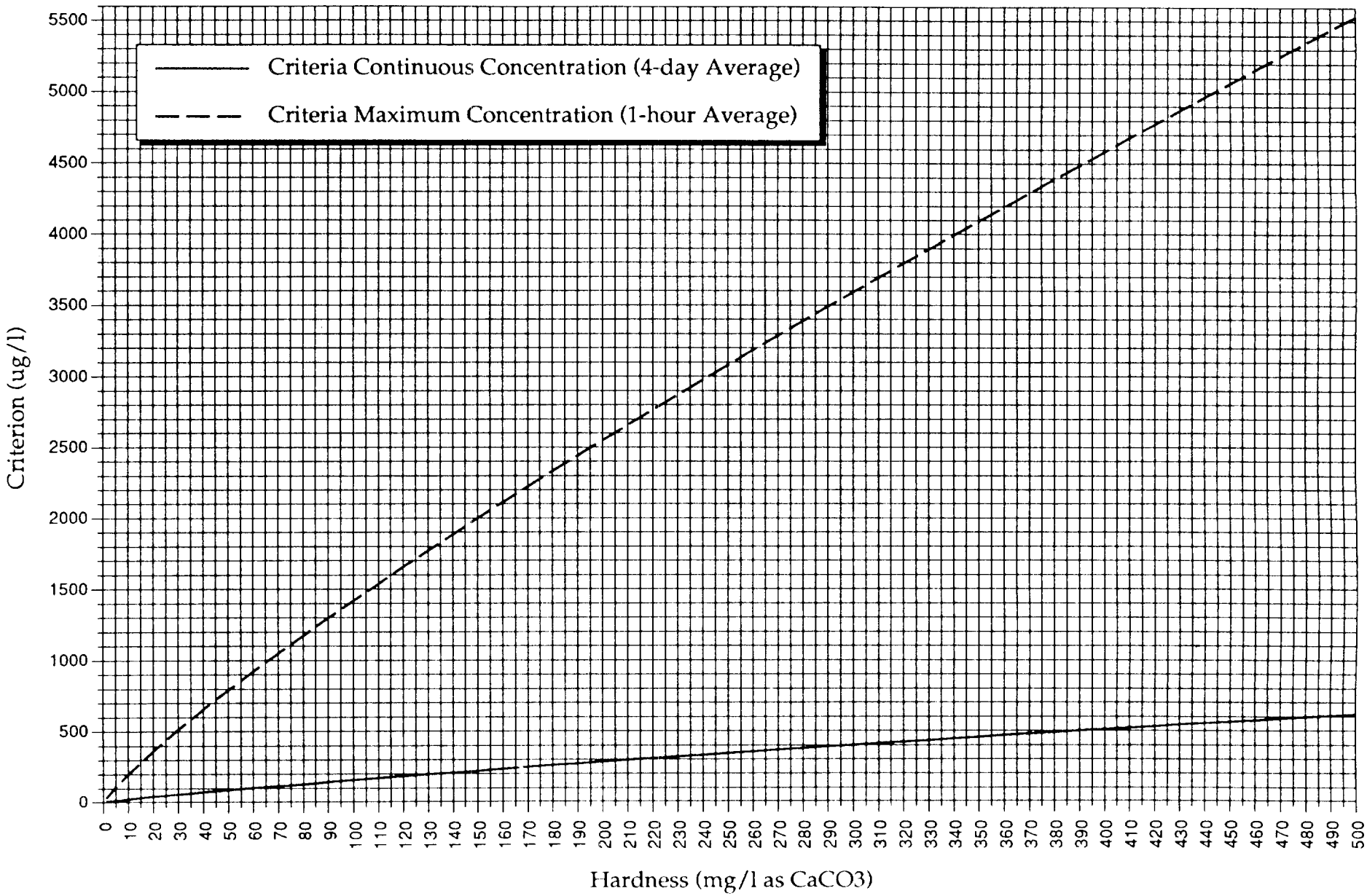
From Reference 13. These data are tabulated on page 7.

NATIONAL AMBIENT WATER QUALITY CRITERIA TO PROTECT FRESHWATER AQUATIC LIFE — LEAD



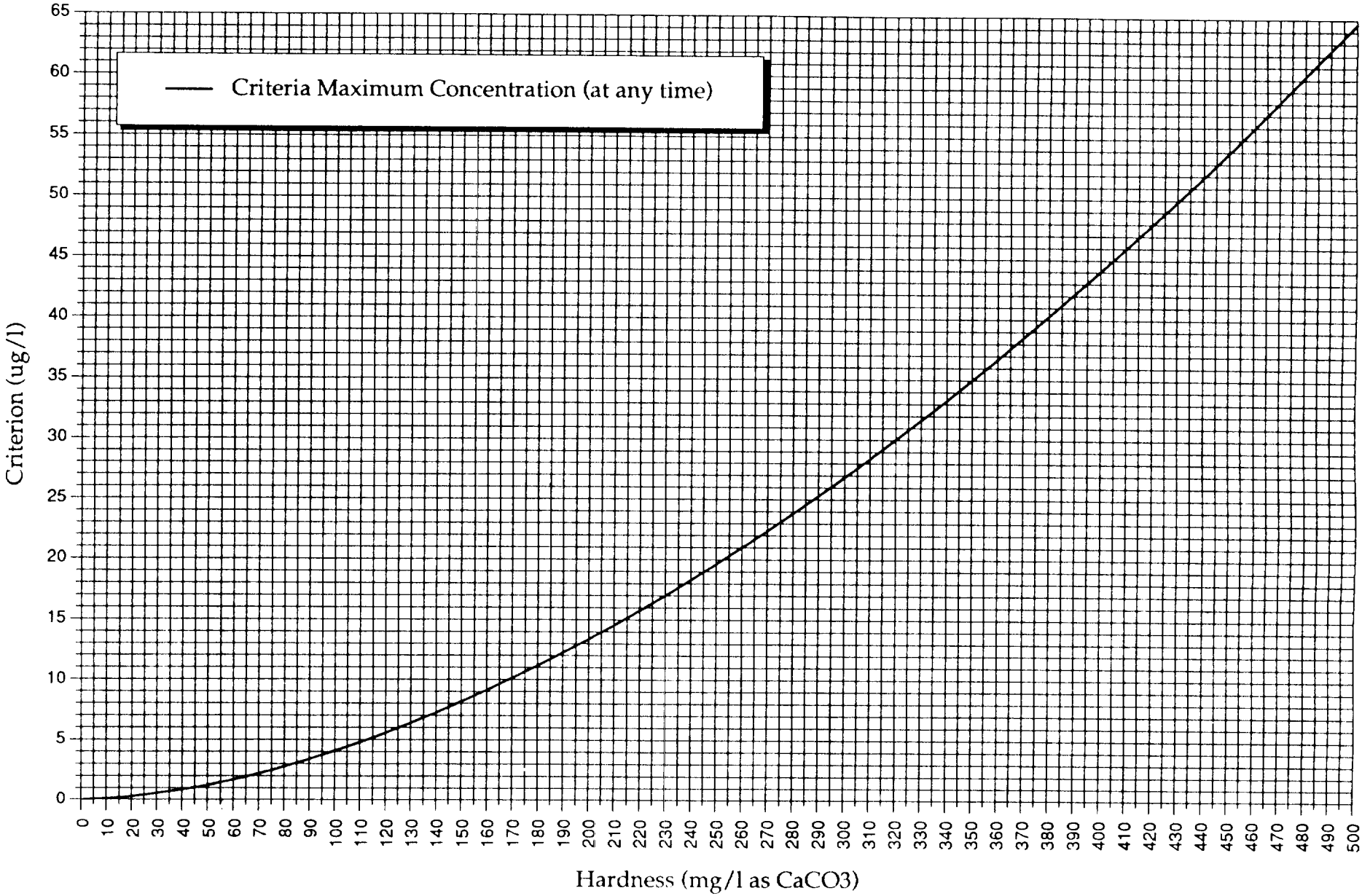
From Reference 13. These data are tabulated on page 7.

NATIONAL AMBIENT WATER QUALITY CRITERIA TO PROTECT FRESHWATER AQUATIC LIFE — NICKEL



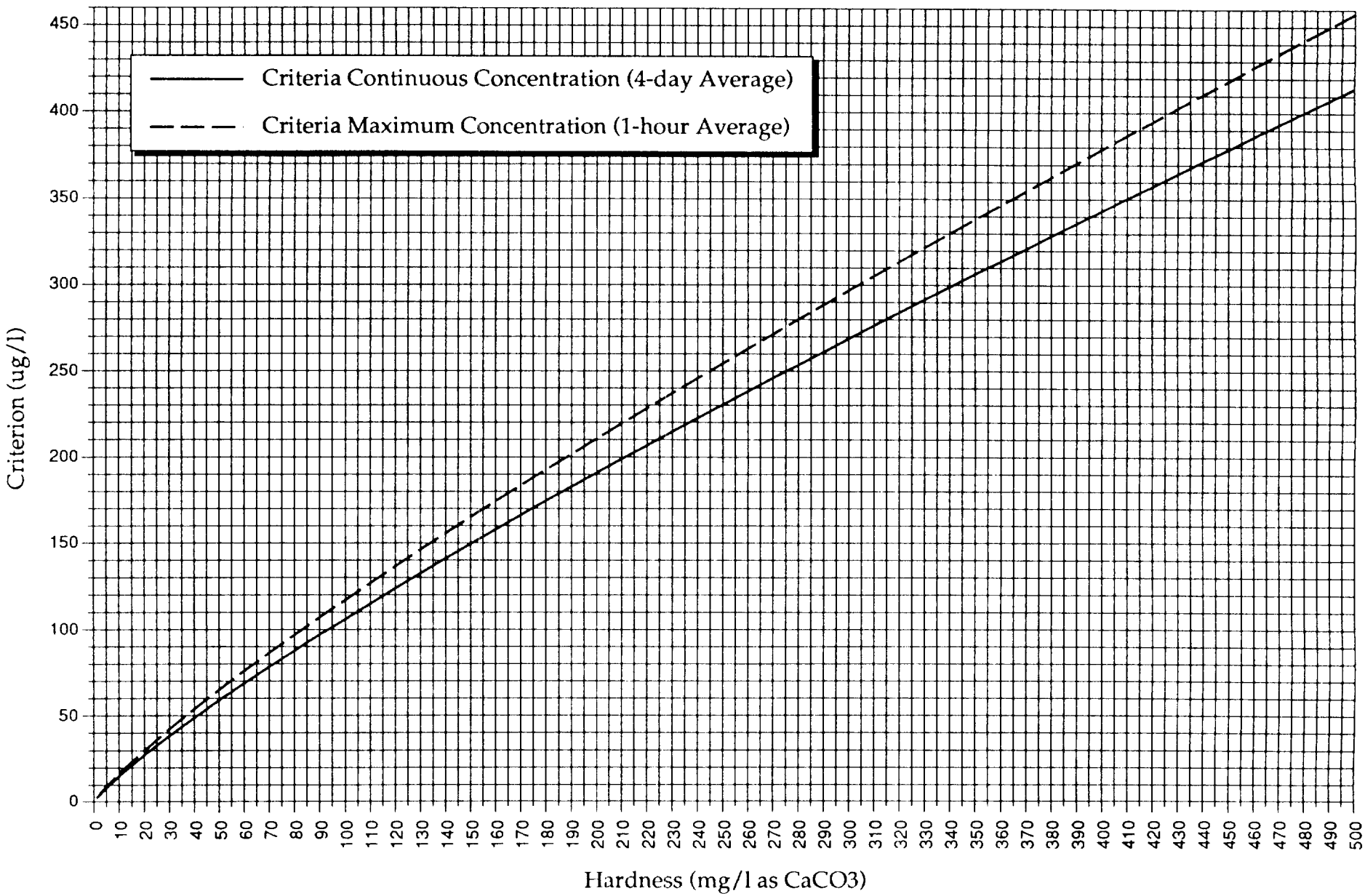
From Reference 13. These data are tabulated on page 7.

NATIONAL AMBIENT WATER QUALITY CRITERIA TO PROTECT FRESHWATER AQUATIC LIFE — SILVER



From Reference 13. These data are tabulated on page 7.

NATIONAL AMBIENT WATER QUALITY CRITERIA TO PROTECT FRESHWATER AQUATIC LIFE — ZINC



From Reference 13. These data are tabulated on page 7.

WATER QUALITY GOALS - ORGANIC CONSTITUENTS
HUMAN HEALTH AND WELFARE

ORGANIC CONSTITUENT	Drinking Water Standards (California & Federal) Maximum Contaminant Levels (MCLs)					California State Action Levels Department of Health Services		Health Advisories or Suggested No-Adverse-Response Levels (SNARLs) (also see cancer risk estimates)		California Proposition 65 Regulatory Level as a Water Quality Criterion (14)	One-in-a-Million Incremental Cancer Risk Estimates		
	California Dept. of Health Services		U. S. Environmental Protection Agency								U.S.EPA National Ambient Water Quality Criteria	U.S. EPA Health or Water Quality Advisories	National Academy of Sciences (NAS)
	Primary MCL	Secondary MCL	Primary MCL	Secondary MCL	MCL Goal	Toxicity	Taste & Odor	EPA	NAS				
Acenaphthene													
Acenaphthylene											0.0028 (41)	(D)	
Acetaldehyde										45			
Acifluorfen								100 / 400 (7-yr,7)				1 (B2)	
Acrolein												(C)	
Acrylamide			(105)		zero (93)			20 / 70 (7-yr,7)		0.1		0.01 (B2)	0.024
Acrylonitrile								1 / 4 (7-yr,7,68)		0.35	0.058	0.07 (B1,68)	0.38
Alachlor			2 (93)		zero (93)	0.2		100 (10-day)	700			0.4 (B2)	
Aldicarb			3 (107)		1 (107)	10		1	0.2 / 0.7 (7)			(D)	2.3 (21)
Aldicarb sulfone			2 (107)		1 (107)			2				(D)	
Aldicarb sulfoxide			4 (107)		1 (107)			1				(D)	
Aldrin						0.05		0.3 (10-day,68)		0.02	0.000074	0.002 (B2,68)	0.003
Ametryn								60				(D)	
Aniline										50			
Anthracene											0.0028 (41)	(D)	
Atrazine	3		3 (93)		3 (93)			3	150			(C)	
Azinphos-methyl									87.5				
Azobenzene										3			
Baygon						90		3				(C)	
Benefin									700				
Bentazon	18							20				(D)	
Benz(a)anthracene			0.1 (100)		zero (100)						0.0028 (41)	(B2)	
Benzene	1		5		zero			200 (10-day)		3.5	0.66	1 (A)	
Benzenes, chlorinated													
Benzenes, dichloro-													
Benzenes, trichloro-													
Benzidine										0.0005	0.00012	(A)	
Benzidines, dichloro-											0.01		
Benzo(b)fluoranthene			0.2 (100)		zero (100)						0.0028 (41)	(B2)	
Benzo(k)fluoranthene			0.2 (100)		zero (100)						0.0028 (41)	(B2)	
Benzo(g,h,i)perylene											0.0028 (41)	(D)	
Benzo(a)pyrene			0.2 (100)		zero (100)					0.03	0.0028 (41)	(B2)	
alpha-BHC						0.7			500 (7-day,43)	0.15	0.0092		0.33
beta-BHC						0.3			500 (7-day,43)	0.25	0.0163		0.12
gamma-BHC (Lindane)	4		4 / 0.2(93)		0.2 (93)			0.2	500 (7-day,43)	0.3	0.0186	0.03 (C)	0.054
delta-BHC									500 (7-day,43)				
technical-BHC									500 (7-day)	0.1	0.0123		
Bis(2-chloroethyl) ether										0.15	0.03		0.42
Bis(2-chloroethoxy) methane													
Bis(2-chloroisopropyl) ether								300				(D)	
Bis(chloromethyl) ether										0.01	0.00000376		
Bromacil								90	87.5			(C)	
Bromochloromethane								90 (68)					
Bromodichloromethane	100 (19)		100 (19)					400 / 1300 (7-yr,7,68)			0.19	0.3 (B2,68)	
Bromoform	100 (19)		100 (19)					2000 (10-day,68)			0.19	4 (B2,68)	
Bromomethane								10			0.19	(D)	
4-Bromophenyl phenyl ether													
Butachlor									70				
1,3-Butadiene										0.2			
Butylate								350				(D)	
n-Butyl benzyl phthalate			100 (100)		100 (100)							(C)	
Captan						350			350			(B2)	
Carbaryl						60		700	574			(D)	
Carbofuran	18		40 (93)		40 (93)			40				(E)	
Carbon tetrachloride	0.5		5		zero			70 / 300 (7-yr,7)	200 (7-day)	2.5	0.4	0.3 (B2)	4.5
Carboxin								700				(D)	
Catechol									2200 (24-hr)				
Chloramben								100	1750			(D)	
Chlordane	0.1		2 (93)		zero (93)			60 (10-day)		0.25	0.00046	0.03 (B2)	0.028
Chlorobenzene	30		100 (93)		100 (93)			100				(D)	2.3 (21)

Values are in µg/l (ppb) unless otherwise indicated. Numbers in parentheses indicate footnotes.

WATER QUALITY GOALS – ORGANIC CONSTITUENTS
HUMAN HEALTH AND WELFARE

ORGANIC CONSTITUENT	Drinking Water Standards (California & Federal) Maximum Contaminant Levels (MCLs)					California State Action Levels Department of Health Services		Health Advisories or Suggested No-Adverse-Response Levels (SNARLs) (also see cancer risk estimates)		California Proposition 65 Regulatory Level as a Water Quality Criterion (14)	One-in-a-Million Incremental Cancer Risk Estimates		
	California Dept. of Health Services		U. S. Environmental Protection Agency								U.S.EPA National Ambient Water Quality Criteria	U.S. EPA Health or Water Quality Advisories	National Academy of Sciences (NAS)
	Primary MCL	Secondary MCL	Primary MCL	Secondary MCL	MCL Goal	Toxicity	Taste & Odor	EPA	NAS				
4-Chloro-o-cresol													
4-Chloro-m-cresol													
6-Chloro-m-cresol													
Chloroform	100 (19)		100 (19)					100 / 500 (7-yr,7,68)		4.5	0.19	6 (B2,68)	0.26 / 5.6 (44)
Chloromethane								3 (68)			0.19	(C)	
2-Chloronaphthalene													
2-Chlorophenol								40 (68)				(D)	
3-Chlorophenol													
4-Chlorophenol													
Chloropicrin						50	37		12 / 40 (7)				
3-Chloropropene										15			
Chlorothalonil								200 (10-day)				1.5 (B2)	
2-Chlorotoluene								100				(D)	
4-Chlorotoluene								100				(D)	
Chlorpropham						350							
Chlorpyrifos								20 (68)				(D)	
Chrysene			0.2 (100)		zero (100)						0.0028 (41)	(B2)	
Cyanazine								10				(D)	
2,4-D	100		100 / 70(93)		100 / 70(93)			70	87.5			(D)	
Dacthal (DCPA)								4000				(D)	
Dalapon			200 (100)		200 (100)			200				(D)	
DBCP	0.2		0.2 (93)		zero (93)			50 (10-day)		0.05	0.025	0.03 (B2)	0.051
DDD										1 (50)			
DDE										1 (50)			
DDT										1 (50)	0.000024	(B2)	0.042
Demeton													
Diazinon						14		0.6	14			(E)	
Dibenz(a,h)anthracene			0.3 (100)		zero (100)						0.0028 (41)	(B2)	
Dibromoacetonitrile								20 (68)	23 / 161 (7)			(C)	
Dibromochloromethane	100 (19)		100 (19)					20 (68)	18,000 (24-hr)			(C)	0.6
Dibutyl phthalate					800 (100)				770			(D)	
Dicamba								200	8.75			(D)	
Dichloroacetic acid								3 (68)	175 / 420 (7)			(C)	
Dichloroacetonitrile								6 (68)				(C)	
1,2-Dichlorobenzene			600 (93)	10 (100)	600 (93)	130 (77)	10	600	300 (25)			(D)	
1,3-Dichlorobenzene						130 (77)	20	600				(D)	
1,4-Dichlorobenzene	5		75	5 (100)	75			75	94 (25)	10		(C)	
3,3-Dichlorobenzidine										0.3	0.01 (52)		
Dichlorodifluoromethane								1000	5600 (7-day)		0.19	(D)	
1,1-Dichloroethane	5												
1,2-Dichloroethane	0.5		5		zero			700 (10-day)		5	0.94	0.4 (B2)	0.71
1,1-Dichloroethylene	6		7		7			7	100		0.033	0.06 (C,68)	
cis-1,2-Dichloroethylene	6		70 (93)		70 (93)			70				(D)	
trans-1,2-Dichloroethylene	10		100 (93)		100 (93)			100				(D)	
Dichloromethane			5 (100)		zero (100)	40		1500 (10-day)	5000 (7-day)	25	0.19	5 (B2)	
2,3-Dichlorophenol													
2,4-Dichlorophenol								20 (68)	2000 / 7000 (7)			(D)	
2,5-Dichlorophenol													
2,6-Dichlorophenol													
3,4-Dichlorophenol													
1,2-Dichloropropane	5		5 (93)		zero (93)			90 (10-day)				0.5 (B2)	
1,3-Dichloropropene	0.5							30 (10-day)				0.2 (B2)	0.45
Dichlorvos										1			
Dieldrin						0.05		0.5 (10-day)		0.02	0.000071	0.002 (B2)	0.0019
Diesel Oil								100 (10-day)					
Di(ethylhexyl) adipate			500 (100)		500 (100)			500				(C)	
Di(2-ethylhexyl)phthalate	4		4 (100)		zero (100)				4200	40		3 (B2,68)	2.4
Diethyl phthalate					5000 (100)			5000 (68)				(D)	
Diisopropyl methyl phosphonate								600				(D)	
Dimethoate						140							

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WATER QUALITY GOALS – ORGANIC CONSTITUENTS
HUMAN HEALTH AND WELFARE

ORGANIC CONSTITUENT	Drinking Water Standards (California & Federal) Maximum Contaminant Levels (MCLs)					California State Action Levels Department of Health Services		Health Advisories or Suggested No-Adverse-Response Levels (SNARLs) (also see cancer risk estimates)		California Proposition 65 Regulatory Level as a Water Quality Criterion (14)	One-in-a-Million Incremental Cancer Risk Estimates		
	California Dept. of Health Services		U. S. Environmental Protection Agency								U.S.EPA National Ambient Water Quality Criteria	U.S. EPA Health or Water Quality Advisories	National Academy of Sciences (NAS)
	Primary MCL	Secondary MCL	Primary MCL	Secondary MCL	MCL Goal	Toxicity	Taste & Odor	EPA	NAS				
Dimethrin								2000				(D)	
2,4-Dimethylphenol							400						
Dimethyl phthalate												(D)	
1,3-Dinitrobenzene								1				(D)	
2,4-Dinitro-o-cresol													
Dinitrophenol									110				
2,4-Dinitrophenol									110				
2,4-Dinitrotoluene										1	0.11	0.113	
2,6-Dinitrotoluene													
Dinoseb			7 (100)		7 (100)			7	39			(D)	
Di(n-octyl) phthalate													
1,4-Dioxane								400 (10-day)		15		7 (B2)	
Diphenamid						40		200				(D)	
1,2-Diphenylhydrazine											0.042		
Diquat			20 (100)		20 (100)			20				(D)	
Disyston								0.3	0.7			(E)	
Diuron								10				(D)	
Endosulfan													
Endosulfan sulfate								74 (104)					
Endothall			100 (100)		100 (100)			100				(D)	
Endrin	0.2		0.2 / 2(100)		2 (100)			2				(D)	
Epichlorohydrin			(105)		zero (93)			70 (7-yr)	530 (7-day)	4.5		4 (B2)	
Ethers, chloroalkyl-													
Ethers, halo-													
Ethion						35							
Ethylbenzene	680		700 (93)	30 (100)	700 (93)			700				(D)	
Ethylene dibromide (EDB)	0.02		0.05 (93)		zero (93)			8 (10-day)		0.1		0.0004 (B2)	0.055
Ethylene glycol								7000				(D)	
Ethylene oxide (ETO)										10(5) / 1			
Ethylenes, dichloro-													
Ethylene thiourea (ETU)								100 / 400 (7-yr,7)				0.06 (B2)	0.23
Fenamiphos								2				(D)	
Ferbam									87.5				
Fluometuron								90				(D)	
Fluoranthene												(D)	
Fluorene											0.0028 (41)	(D)	
Folpet									1120	100		(B2)	
Fonofos								10				(D)	
Formaldehyde						30		1000 (68)		7.5		(B1-inhalation)	
Furmecyclox										10			
Glyphosate	700		700 (100)		700 (100)			700				(D)	
Heptachlor	0.01		0.4 (93)		zero (93)			5 (7-yr)		0.1	0.00028	0.008 (B2)	0.012
Heptachlor epoxide	0.01		0.2 (93)		zero (93)			0.1 (7-yr)		0.04		0.004 (B2)	
Hexachlorobenzene			1 (100)		zero (100)			50 (10-day)	30 (7-day)	0.2	0.00072	0.02 (B2)	0.017
Hexachlorobutadiene								1			0.45	0.5 (C)	
Hexachlorocyclopentadiene			50 (100)	8 (100)	50 (100)							(D)	
Hexachloroethane								1			1.9	(C)	
Hexachlorophene								0.35 (68)	7				
n-Hexane								4000 (10-day)				(D)	
Hexazinone								200				(D)	
HMX								400				(D)	
Indeno(1,2,3-c,d)pyrene			0.4 (100)		zero (100)						0.0028 (41)	(B2)	
Isophorone								100 (68)				9 (C)	
Isopropanol								1000 (24-hr,68)					
Kepone													0.011
Kerosene								100 (10-day)					
Malathion						160		200 (68)	160			(D)	
Maleic hydrazide								4000				(D)	
Maneb									35				
MCPA								11	8.75			(E)	

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WATER QUALITY GOALS — ORGANIC CONSTITUENTS
HUMAN HEALTH AND WELFARE

ORGANIC CONSTITUENT	Drinking Water Standards (California & Federal) Maximum Contaminant Levels (MCLs)					California State Action Levels Department of Health Services		Health Advisories or Suggested No-Adverse-Response Levels (SNARLs) (also see cancer risk estimates)		California Proposition 65 Regulatory Level as a Water Quality Criterion (14)	One-in-a-Million Incremental Cancer Risk Estimates		
	California Dept. of Health Services		U. S. Environmental Protection Agency								U.S.EPA National Ambient Water Quality Criteria	U.S. EPA Health or Water Quality Advisories	National Academy of Sciences (NAS)
	Primary MCL	Secondary MCL	Primary MCL	Secondary MCL	MCL Goal	Toxicity	Taste & Odor	EPA	NAS				
Methanes, halo			100 (19)										
Methomyl								200	175			(D)	
Methoxychlor	100		100 / 40(93)		100 / 40(93)			40	700			(D)	
Methyl t-butyl ether (MTBE)								40 (68)				(D)	
4,4' Methylene bis(N,N-dimethylaniline)										10			
Methyl ethyl ketone (MEK)								200				(D)	
Methyl methacrylate								35 (68)	800				
Methyl parathion						30		2	30			(D)	
Metolachlor								100				(C)	
Metribuzin								200				(D)	
Mirex												4.9 / 0.093ng/l (51,B2)	
Molinate	20												
Nabam													
Naphthalene								20				(D)	
Naphthalenes, chlorinated													
Nitralin									700				
Nitrobenzene									5 (7-day)				
Nitrofen													0.0089
Nitroguanidine								700				(D)	
2-Nitrophenol									290 (7-day,37)				
4-Nitrophenol								60 (68)	290 (7-day,37)			(D)	
Nitrophenol									290 (7-day)				
Nitrosamines													
N-Nitrosodi-n-butylamine										0.03	0.0064	0.0064	
N-Nitrosodiethanolamine										0.15			
N-Nitrosodiethylamine										0.01	0.0008		
N-Nitrosodimethylamine										0.02	0.0014		
N-Nitrosodiphenylamine										40	4.9		
N-Nitrosodipropylamine										0.05			
N-Nitroso-N-ethylurea										0.015			
N-Nitrosomethylethylamine										0.015			
N-Nitroso-N-methylurea										0.003			
N-Nitrosopyrrolidine										0.15	0.016		
trans-Nonachlor													
Oil & grease													
Oxamyl			200 (100)		200 (100)			200				(E)	
Oxychlordane													
PAHs			see individual chemicals		see individual chemicals			see individual chemicals			0.0028		
Paraquat								30	59.5			(E)	
Parathion						30			30			(C)	
Pentachlorobenzene													
Pentachloroethane													
Pentachloronitrobenzene						0.9						(C)	3.6
Pentachlorophenol			1 (107)	30 (100)	zero (107)	30		300 (10-day)	6 / 21 (7)	20		0.3 (B2)	
Phenanthrene											0.0028 (41)		
Phenol							5.0 (39)	4000 (68)				(D)	
Phenols, chlorinated													
Phenols, nitro-													
Phenols, non-chlorinated													
Phorate									0.7				
Phthalate esters	see individual chemicals		see individual chemicals		see individual chemicals			see individual chemicals	see individ. chemicals	see individ. chemicals		see individual chemicals	see individ. chemicals
Picloram			500 (100)		500 (100)			500	1050			(D)	
Polybrominated biphenyls										0.01			
Polychlorinated biphenyls			0.5 (106)		zero (106)				50 (7-day)	0.045	0.000079	0.005 (B2)	0.16 (69)
Prometon								100				(D)	
Pronamide								50				(C)	
Propachlor								90	700			(D)	
Propanes, dichloro-													
Propanil									140				
Propazine								10	325			(C)	

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WATER QUALITY GOALS - ORGANIC CONSTITUENTS
HUMAN HEALTH AND WELFARE

ORGANIC CONSTITUENT	Drinking Water Standards (California & Federal) Maximum Contaminant Levels (MCLs)					California State Action Levels Department of Health Services		Health Advisories or Suggested No-Adverse-Response Levels (SNARLs) (also see cancer risk estimates)		California Proposition 65 Regulatory Level as a Water Quality Criterion (14)	One-in-a-Million Incremental Cancer Risk Estimates		
	California Dept. of Health Services		U. S. Environmental Protection Agency								U.S.EPA National Ambient Water Quality Criteria	U.S. EPA Health or Water Quality Advisories	National Academy of Sciences (NAS)
	Primary MCL	Secondary MCL	Primary MCL	Secondary MCL	MCL Goal	Toxicity	Taste & Odor	EPA	NAS				
Propenes, dichloro-								100				(D)	
Propham												(D)	
Pyrene											0.0028 (41)		
RDX (Cyclonite)								2				0.3 (C)	
Resorcinol									500 (7-day)				
Rotenone									14				
Simazine	10		1 (100)		1 (100)			1	1505			(C)	
Styrene			100 (93)	10 (100)	100 (93)			100	931			0.01 (C)	
Sulfallate													0.31
2,4,5-T								70	700			(D)	
2,3,7,8-TCDD (Dioxin)			0.00005 (100)		zero (100)			0.00001 / 0.00004 (7 yr,7)	0.0007	0.0000025	0.000000013	0.0000002 (B2)	
Tebuthiuron								500				(D)	
Terbacil								90				(E)	
Terbufos								0.9				(D)	
1,2,4,5-Tetrachlorobenzene													
1,1,1,2-Tetrachloroethane								70				1 (C)	
1,1,2,2-Tetrachloroethane	1										0.17	(C)	
Tetrachloroethylene (PCE)	5		5 (93)		zero (93)			1000 / 5000 (7-yr,7)		7	0.8	0.7 (B2)	3.6
2,3,4,6-Tetrachlorophenol													
2,3,5,6-Tetrachlorophenol													
Thiobencarb	70	1											
Thiram									35				
Toluene			1000 (93)	40 (100)	1000 (93)	100		1000	340			(D)	
Toxaphene	5		5 / 3(93)		zero (93)			40 (10-day)	8.75	0.3	0.00071	0.03 (B2)	
2,4,5-TP (Silvex)	10		10 / 50(93)		50 (93)			50	5.25			(D)	
Tributyltin													
Trichloroacetaldehyde, hydrated								50 (68)				(D)	
Trichloroacetic acid								200 (68)	50 / 120 (7)			(C)	
Trichloroacetonitrile								50 (10-day,68)					
Trichlorfon									26 / 88 (7)				
1,2,4-Trichlorobenzene			9 (100)		9 (100)			9				(D)	
1,3,5-Trichlorobenzene								40				(D)	
1,1,1-Trichloroethane	200		200		200			200	3800			(D)	17 (21)
1,1,2-Trichloroethane	32		5 (100)		3 (100)			3			0.6	0.6 (C)	
Trichloroethylene (TCE)	5		5		zero					30	2.7	3 (B2)	1.5 (21)
Trichlorofluoromethane	150							2000	8000 (7-day)		0.19	(D)	
2,4,5-Trichlorophenol									2500 (7-day)	5	1.2	3 (B2,68)	
2,4,6-Trichlorophenol								40					
1,2,3-Trichloropropane													
1,1,2-Trichloro-1,2,2-trifluoroethane	1200												
Trifluralin								5	700			5 (C)	
Trinitroglycerol								5					
Trinitrophenol									200 (7-day)				
Trinitrotoluene (TNT)								2				1 (C)	
Trithion						7.0							
Urethane										0.35			
Vinyl chloride	0.5		2		zero			10 / 50 (7-yr,7)		0.15	2	0.015 (A)	1.1
Xylene(s)	1750		10,000 (93)	20 (100)	10,000 (93)			10,000				(D)	
Zineb									35				
Ziram									87.5				

Values are in µg/l (ppb) unless otherwise indicated. Numbers in parentheses indicate footnotes.

WATER QUALITY GOALS — ORGANIC CONSTITUENTS
AGRICULTURAL USE, HEALTH & WELFARE, AND FRESHWATER AQUATIC LIFE

ORGANIC CONSTITUENT	Agricultural Water Quality Goals (78)	U. S. EPA National Ambient Water Quality Criteria								
		Health & Welfare Protection		Freshwater Aquatic Life Protection						
				Recommended Criteria				Toxicity Information		
		Public Health Effects	Taste & Odor or Welfare	Continuous Concentration (4-day Average)	24-hour Average	Maximum Concentration (1-hour Average)	Maximum	Acute	Chronic	Other
Acenaphthene			20					1700		520 (38)
Acenaphthylene										
Acetaldehyde										
Acifluorfen										
Acrolein		320						68	21	
Acrylamide										
Acrylonitrile								7550		2600 (17)
Alachlor							76 (18)			
Aldicarb										
Aldicarb sulfone										
Aldicarb sulfoxide										
Aldrin							3			
Ametryn										
Aniline										
Anthracene										
Atrazine							1 (18)			
Azinphos-methyl							0.01			
Azobenzene										
Baygon										
Benefin										
Bentazon										
Benz(a)anthracene										
Benzene								5300		
Benzenes, chlorinated								250		50 (23)
Benzenes, dichloro-		400						1120	763 µg/l	
Benzenes, trichloro-								250 (22)		50 (22,23)
Benzidine								2500		
Benzidines, dichloro-										
Benzo(b)fluoranthene										
Benzo(k)fluoranthene										
Benzo(g,h,i)perylene										
Benzo(a)pyrene										
alpha-BHC										
beta-BHC										
gamma-BHC (Lindane)					0.08		2.0			
delta-BHC										
technical-BHC								100		
Bis(2-chloroethyl) ether								238,000 (46)	122 (58)	
Bis(2-chloroethoxy) methane										
Bis(2-chloroisopropyl) ether		34.7						238,000 (46)	122 (58)	
Bis(chloromethyl) ether								238,000 (46)	122 (58)	
Bromacil										
Bromochloromethane										
Bromodichloromethane								11,000 (20)		
Bromoform								11,000 (20)		
Bromomethane								11,000 (20)		
4-Bromophenyl phenyl ether								360 (58)	122 (58)	
Butachlor										
1,3-Butadiene										
Butylate										
n-Butyl benzyl phthalate								940 (45)	3 (45)	
Captan										
Carbaryl							0.02 (54)			
Carbofuran										
Carbon tetrachloride								35,200		
Carboxin										
Catechol										
Chloramben										
Chlordane					0.0043		2.4			
Chlorobenzene		488	20					250 (22)		50 (22,23)

Values are in µg/l (ppb) unless otherwise indicated. Numbers in parentheses indicate footnotes.

WATER QUALITY GOALS — ORGANIC CONSTITUENTS
AGRICULTURAL USE, HEALTH & WELFARE, AND FRESHWATER AQUATIC LIFE

ORGANIC CONSTITUENT	Agricultural Water Quality Goals (78)	U. S. EPA National Ambient Water Quality Criteria: Health & Welfare Protection: Public Health Effects	Health & Welfare Protection: Taste & Odor or Welfare	Freshwater Aquatic Life Protection: Recommended Criteria: Continuous Concentration (4-day Average)	Recommended Criteria: 24-hour Average	Recommended Criteria: Maximum Concentration (1-hour Average)	Recommended Criteria: Maximum	Toxicity Information: Acute	Toxicity Information: Chronic	Toxicity Information: Other
4-Chloro-o-cresol			1800							
4-Chloro-m-cresol			3000					30		
6-Chloro-m-cresol			20							
Chloroform								28,900	1240	
Chloromethane								11,000 (20)		
2-Chloronaphthalene								1600 (48)		
2-Chlorophenol			0.1					4,380		2000 (34)
3-Chlorophenol			0.1							
4-Chlorophenol			0.1							
Chloropicrin										
3-Chloropropene										
Chlorothalonil										
2-Chlorotoluene										
4-Chlorotoluene										
Chlorpropham										
Chlorpyrifos				0.041		0.083				
Chrysene										
Cyanazine										
2,4-D		100								
Dacthal (DCPA)							14,300 (18)			
Dalapon							110 (54)			
DBCP										
DDD					0.0010 (50)		1.1 (50)	0.6		
DDE					0.0010 (50)		1.1 (50)	1050		
DDT					0.0010 (50)		1.1 (50)			
Demeton							0.1			
Diazinon							0.009 (54)			
Dibenz(a,h)anthracene										
Dibromoacetonitrile										
Dibromochloromethane								11,000 (20)		
Dibutyl phthalate		34,000						940 (45)	3 (45)	
Dicamba							200 (54)			
Dichloroacetic acid										
Dichloroacetonitrile										
1,2-Dichlorobenzene		400 (24)						1120 (24)	763 (24)	
1,3-Dichlorobenzene		400 (24)						1120 (24)	763 (24)	
1,4-Dichlorobenzene		400 (24)						1120 (24)	763 (24)	
3,3'-Dichlorobenzidine										
Dichlorodifluoromethane								11,000 (20)		
1,1-Dichloroethane										
1,2-Dichloroethane								118,000	20,000	
1,1-Dichloroethylene								11,600 (27)		
cis-1,2-Dichloroethylene								11,600 (27)		
trans-1,2-Dichloroethylene								11,600 (27)		
Dichloromethane								11,000 (20)		
2,3-Dichlorophenol			0.04							
2,4-Dichlorophenol		3090	0.3					2020	365	70 (35)
2,5-Dichlorophenol			0.5							
2,6-Dichlorophenol			0.2							
3,4-Dichlorophenol			0.3							
1,2-Dichloropropane								23,000 (28)	5700 (28)	
1,3-Dichloropropene		87 (29)						6060 (29)	244 (29)	
Dichlorvos										
Dieldrin					0.0019		2.5			
Diesel Oil										
Di(ethylhexyl) adipate										
Di(2-ethylhexyl)phthalate		15,000		360 (100)		400 (100)		940 (45)	3 (45)	
Diethyl phthalate		350000						940 (45)	3 (45)	
Diisopropyl methyl phosphonate										
Dimethoate										

Values are in µg/l (ppb) unless otherwise indicated. Numbers in parentheses indicate footnotes.

WATER QUALITY GOALS — ORGANIC CONSTITUENTS

AGRICULTURAL USE, HEALTH & WELFARE, AND FRESHWATER AQUATIC LIFE

ORGANIC CONSTITUENT	Agricultural Water Quality Goals (78)	U. S. EPA National Ambient Water Quality Criteria								
		Health & Welfare Protection		Freshwater Aquatic Life Protection						
				Recommended Criteria				Toxicity Information		
		Public Health Effects	Taste & Odor or Welfare	Continuous Concentration (4-day Average)	24-hour Average	Maximum Concentration (1-hour Average)	Maximum	Acute	Chronic	Other
Methanes, halo-								11,000		
Methomyl										
Methoxychlor		100					0.03			
Methyl t-butyl ether (MTBE)										
4,4'-Methylene bis(N,N-dimethylaniline)										
Methyl ethyl ketone (MEK)										
Methyl methacrylate										
Methyl parathion										
Metolachlor							100 (18)			
Metribuzin							100 (18)			
Mirex							0.001			
Molinate										
Nabam										
Naphthalene								2300	620	
Naphthalenes, chlorinated								1600		
Nitralin										
Nitrobenzene		19,800	30					27,000		
Nitrofen										
Nitroguanidine										
2-Nitrophenol								230 (88)		150 (38,88)
4-Nitrophenol								230 (88)		150 (38,88)
Nitrophenol								230 (88)		150 (38,88)
Nitrosamines								5850		
N-Nitrosodi-n-butylamine								5850 (56)		
N-Nitrosodiethanolamine										
N-Nitrosodiethylamine								5850 (56)		
N-Nitrosodimethylamine								5850 (56)		
N-Nitrosodiphenylamine								5850 (56)		
N-Nitrosodipropylamine								5850 (56)		
N-Nitroso-N-ethylurea										
N-Nitrosomethylethylamine										
N-Nitroso-N-methylurea										
N-Nitrosopyrrolidine								5850 (56)		
trans-Nonachlor										
Oil & grease										
Oxamyl										
Oxychlordane										
PAHs										
Paraquat										
Parathion				0.013		0.065				
Pentachlorobenzene		74						250 (22)		50 (22,23)
Pentachloroethane								7240	1100	
Pentachloronitrobenzene										
Pentachlorophenol		1010	30	Varies with pH (13)		Varies with pH (11)				1.74 (70)
Phenanthrene				6.3 (100)		30 (100)				
Phenol		3500	300					10,200	2560	
Phenols, chlorinated										
Phenols, nitro-								230		150 (38)
Phenols, non-chlorinated										
Phorate										
Phthalate esters		see individ chemicals						940	3	
Picloram										
Polybrominated biphenyls										
Polychlorinated biphenyls					0.014			> 2		
Prometon										
Pronamide										
Propachlor							8 (18)			
Propanes, dichloro-								23,000	5700	
Propanil										
Propazine										

Values are in µg/l (ppb) unless otherwise indicated. Numbers in parentheses indicate footnotes.

WATER QUALITY GOALS – ORGANIC CONSTITUENTS
AGRICULTURAL USE, HEALTH & WELFARE, AND FRESHWATER AQUATIC LIFE

ORGANIC CONSTITUENT	Agricultural Water Quality Goals (78)	U. S. EPA National Ambient Water Quality Criteria								
		Health & Welfare Protection		Freshwater Aquatic Life Protection						
				Recommended Criteria				Toxicity Information		
		Public Health Effects	Taste & Odor or Welfare	Continuous Concentration (4-day Average)	24-hour Average	Maximum Concentration (1-hour Average)	Maximum	Acute	Chronic	Other
Propenes, dichloro-		87						6060	244	
Propham										
Pyrene										
RDX (Cyclonite)										
Resorcinol										
Rotenone							10 (54)			
Simazine							10 (54)			
Styrene										
Sulfallate										
2,4,5-T										
2,3,7,8-TCDD (Dioxin)										
Tebuthiuron										
Terbacil										
Terbufos										
1,2,4,5-Tetrachlorobenzene		38						250 (22)		50 (22,23)
1,1,1,2-Tetrachloroethane										
1,1,2,2-Tetrachloroethane								9320 (47)	2400	
Tetrachloroethylene (PCE)								5280	840	
2,3,4,6-Tetrachlorophenol			1							
2,3,5,6-Tetrachlorophenol										
Thiobencarb										
Thiram										
Toluene		14,300						17,000		
Toxaphene				0.0002		0.73				
2,4,5-TP (Silvex)		10								
Tributyltin							0.026 (8)			
Trichloroacetaldehyde, hydrated										
Trichloroacetic acid										
Trichloroacetonitrile										
Trichlorfon										
1,2,4-Trichlorobenzene								250 (22)		50 (22,23)
1,3,5-Trichlorobenzene										
1,1,1-Trichloroethane		18,400						18,000		200 (33)
1,1,2-Trichloroethane								18,000	9400	
Trichloroethylene (TCE)								45,000		21,900 (31)
Trichlorofluoromethane								11,000 (20)		
2,4,5-Trichlorophenol		2600	1	63 (100)		100 (100)				
2,4,6-Trichlorophenol			2						970	
1,2,3-Trichloropropane										
1,1,2-Trichloro-1,2,2-trifluoroethane										
Trifluralin										
Trinitroglycerol										
Trinitrophenol								230 (88)		150 (38,88)
Trinitrotoluene (TNT)										
Trithion										
Urethane										
Vinyl chloride										
Xylene(s)										
Zineb										
Ziram										

Values are in µg/l (ppb) unless otherwise indicated. Numbers in parentheses indicate footnotes.

WATER QUALITY GOALS — ORGANIC CONSTITUENTS

HEALTH AND AQUATIC LIFE — INLAND SURFACE WATERS AND ENCLOSED BAYS & ESTUARIES

ORGANIC CONSTITUENT	California Inland Surface Waters Plan Numerical Water Quality Objectives						California Enclosed Bays & Estuaries Plan Numerical Water Quality Objectives			
	Human Health Protection (30-day Average) "‡" = carcinogen		Freshwater Aquatic Life Protection				Human Health Protection (30-day Average) "‡" = carcinogen	Saltwater Aquatic Life Protection		
	Sources of Drinking Water	Other Waters	4-day Average	Daily Average	1-hour Average	Instantaneous Maximum		4-day Average	Daily Average	1-hour Average
Acenaphthene										
Acenaphthylene	0.0028 ‡ (115)	0.031 ‡ (115)					0.031 ‡ (115)			
Acetaldehyde										
Acifluorfen										
Acrolein										
Acrylamide										
Acrylonitrile										
Alachlor										
Aldicarb										
Aldicarb sulfone										
Aldicarb sulfoxide										
Aldrin	0.00013 ‡	0.00014 ‡					0.00014 ‡			
Ametryn										
Aniline										
Anthracene	0.0028 ‡ (115)	0.031 ‡ (115)					0.031 ‡ (115)			
Atrazine										
Azinphos-methyl										
Azobenzene										
Baygon										
Benefin										
Bentazon										
Benz(a)anthracene	0.0028 ‡ (115)	0.031 ‡ (115)					0.031 ‡ (115)			
Benzene	0.34 ‡	21 ‡					21 ‡			
Benzenes, chlorinated										
Benzenes, dichloro-										
Benzenes, trichloro-										
Benzidine										
Benzidines, dichloro-										
Benzo(b)fluoranthene	0.0028 ‡ (115)	0.031 ‡ (115)					0.031 ‡ (115)			
Benzo(k)fluoranthene	0.0028 ‡ (115)	0.031 ‡ (115)					0.031 ‡ (115)			
Benzo(g,h,i)perylene	0.0028 ‡ (115)	0.031 ‡ (115)					0.031 ‡ (115)			
Benzo(a)pyrene	0.0028 ‡ (115)	0.031 ‡ (115)					0.031 ‡ (115)			
alpha-BHC	0.0039 ‡	0.013 ‡					0.013 ‡			
beta-BHC	0.014 ‡	0.046 ‡					0.046 ‡			
gamma-BHC (Lindane)	0.019 ‡	0.062 ‡		0.080			0.062 ‡		0.16	
delta-BHC										
technical-BHC										
Bis(2-chloroethyl) ether										
Bis(2-chloroethoxy) methane										
Bis(2-chloroisopropyl) ether										
Bis(chloromethyl) ether										
Bromacil										
Bromochloromethane										
Bromodichloromethane	100 ‡ (113)	480 ‡ (113)					480 ‡ (113)			
Bromoform	100 ‡ (113)	480 ‡ (113)					480 ‡ (113)			
Bromomethane	100 ‡ (113)	480 ‡ (113)					480 ‡ (113)			
4-Bromophenyl phenyl ether										
Butachlor										
1,3-Butadiene										
Butylate										
n-Butyl benzyl phthalate										
Captan										
Carbaryl										
Carbofuran										
Carbon tetrachloride										
Carboxin										
Catechol										
Chloramben										
Chlordane	0.00008 ‡ (82)	0.000081‡ (82)		0.0043 (82)			0.000081‡ (82)		0.0040 (82)	
Chlorobenzene										

Values are in µg/l (ppb) unless otherwise indicated. Numbers in parentheses indicate footnotes.

WATER QUALITY GOALS — ORGANIC CONSTITUENTS

HEALTH AND AQUATIC LIFE — INLAND SURFACE WATERS AND ENCLOSED BAYS & ESTUARIES

ORGANIC CONSTITUENT	California Inland Surface Waters Plan Numerical Water Quality Objectives						California Enclosed Bays & Estuaries Plan Numerical Water Quality Objectives			
	Human Health Protection (30-day Average) "‡" = carcinogen		Freshwater Aquatic Life Protection				Human Health Protection (30-day Average) "‡" = carcinogen	Saltwater Aquatic Life Protection		
	Sources of Drinking Water	Other Waters	4-day Average	Daily Average	1-hour Average	Instantaneous Maximum		4-day Average	Daily Average	1-hour Average
4-Chloro-o-cresol	3000 (36)									
4-Chloro-m-cresol										
6-Chloro-m-cresol										
Chloroform	100 ‡	480 ‡					480 ‡			
Chloromethane	100 ‡ (113)	480 ‡ (113)					480 ‡ (113)			
2-Chloronaphthalene										
2-Chlorophenol										
3-Chlorophenol										
4-Chlorophenol										
Chloropicrin										
3-Chloropropene										
Chlorothalonil										
2-Chlorotoluene										
4-Chlorotoluene										
Chlorpropham										
Chlorpyrifos										
Chrysene	0.0028 ‡ (115)	0.031 ‡ (115)					0.031 ‡ (115)			
Cyanazine										
2,4-D										
Dacthal (DCPA)										
Dalapon										
DBCP										
DDD	0.00059 ‡ (50)	0.00060 ‡ (50)		0.0010 (50)			0.0006 ‡ (50)		0.0010 (50)	
DDE	0.00059 ‡ (50)	0.00060 ‡ (50)		0.0010 (50)			0.0006 ‡ (50)		0.0010 (50)	
DDT	0.00059 ‡ (50)	0.00060 ‡ (50)		0.0010 (50)			0.0006 ‡ (50)		0.0010 (50)	
Demeton										
Diazinon										
Dibenz(a,h)anthracene	0.0028 ‡ (115)	0.031 ‡ (115)					0.031 ‡ (115)			
Dibromoacetonitrile										
Dibromochloromethane	100 ‡ (113)	480 ‡ (113)					480 ‡ (113)			
Dibutyl phthalate										
Dicamba										
Dichloroacetic acid										
Dichloroacetonitrile										
1,2-Dichlorobenzene	2700	18,000					18,000			
1,3-Dichlorobenzene	400	2600					2600			
1,4-Dichlorobenzene	9.9 ‡	64 ‡					64 ‡			
3,3'-Dichlorobenzidine										
Dichlorodifluoromethane										
1,1-Dichloroethane										
1,2-Dichloroethane										
1,1-Dichloroethylene										
cis-1,2-Dichloroethylene										
trans-1,2-Dichloroethylene										
Dichloromethane	4.6 ‡	1600 ‡					1600 ‡			
2,3-Dichlorophenol										
2,4-Dichlorophenol	0.30 (36)									
2,5-Dichlorophenol										
2,6-Dichlorophenol										
3,4-Dichlorophenol										
1,2-Dichloropropane										
1,3-Dichloropropene										
Dichlorvos										
Dieldrin	0.00014 ‡	0.00014 ‡		0.0019			0.00014 ‡		0.0019	
Diesel Oil										
Di(ethylhexyl) adipate										
Di(2-ethylhexyl)phthalate										
Diethyl phthalate										
Diisopropyl methyl phosphonate										
Dimethoate										

Values are in µg/l (ppb) unless otherwise indicated. Numbers in parentheses indicate footnotes.

WATER QUALITY GOALS — ORGANIC CONSTITUENTS

HEALTH AND AQUATIC LIFE — INLAND SURFACE WATERS AND ENCLOSED BAYS & ESTUARIES

ORGANIC CONSTITUENT	California Inland Surface Waters Plan Numerical Water Quality Objectives						California Enclosed Bays & Estuaries Plan Numerical Water Quality Objectives			
	Human Health Protection (30-day Average) "‡" = carcinogen		Freshwater Aquatic Life Protection				Human Health Protection (30-day Average) "‡" = carcinogen	Saltwater Aquatic Life Protection		
	Sources of Drinking Water	Other Waters	4-day Average	Daily Average	1-hour Average	Instantaneous Maximum		4-day Average	Daily Average	1-hour Average
Dimethrin										
2,4-Dimethylphenol										
Dimethyl phthalate										
1,3-Dinitrobenzene										
2,4-Dinitro-o-cresol										
Dinitrophenol										
2,4-Dinitrophenol										
2,4-Dinitrotoluene										
2,6-Dinitrotoluene										
Dinoseb										
Di(n-octyl) phthalate										
1,4-Dioxane										
Diphenamid										
1,2-Diphenylhydrazine										
Diquat										
Disyston										
Diuron										
Endosulfan	0.9 (42)	2.0 (42)		0.056 (42)		0.22 (42)	2.0 (42)		0.0087 (42)	0.034 (42)
Endosulfan sulfate	0.9 (42)	2.0 (42)		0.056 (42)		0.22 (42)	2.0 (42)		0.0087 (42)	0.034 (42)
Endothall										
Endrin	0.8	0.8		0.0023		0.18	0.8		0.0023	0.037
Epichlorohydrin										
Ethers, chloroalkyl-										
Ethers, halo-										
Ethion										
Ethylbenzene										
Ethylene dibromide (EDB)										
Ethylene glycol										
Ethylene oxide (ETO)										
Ethylenes, dichloro-										
Ethylene thiourea (ETU)										
Fenamiphos										
Ferbam										
Fluometuron										
Fluoranthene	42	42					42			
Fluorene	0.0028 ‡ (115)	0.031 ‡ (115)					0.031 ‡ (115)			
Folpet										
Fonofos										
Formaldehyde										
Furmecyclox										
Glyphosate										
Heptachlor	0.00016 ‡	0.00017 ‡		0.0038			0.00017 ‡		0.0036	
Heptachlor epoxide	0.00007 ‡	0.00007 ‡					0.00007 ‡			
Hexachlorobenzene	0.00066 ‡	0.00069 ‡					0.00069 ‡			
Hexachlorobutadiene										
Hexachlorocyclopentadiene										
Hexachloroethane										
Hexachlorophene										
n-Hexane										
Hexazinone										
HMX										
Indeno(1,2,3-c,d)pyrene	0.0028 ‡ (115)	0.031 ‡ (115)					0.031 ‡ (115)			
Isophorone										
Isopropanol										
Kepone										
Kerosene										
Malathion										
Maleic hydrazide										
Maneb										
MCPA										

Values are in µg/l (ppb) unless otherwise indicated. Numbers in parentheses indicate footnotes.

WATER QUALITY GOALS — ORGANIC CONSTITUENTS

HEALTH AND AQUATIC LIFE — INLAND SURFACE WATERS AND ENCLOSED BAYS & ESTUARIES

ORGANIC CONSTITUENT	California Inland Surface Waters Plan Numerical Water Quality Objectives						California Enclosed Bays & Estuaries Plan Numerical Water Quality Objectives			
	Human Health Protection (30-day Average) "‡" = carcinogen		Freshwater Aquatic Life Protection				Human Health Protection (30-day Average) "‡" = carcinogen	Saltwater Aquatic Life Protection		
	Sources of Drinking Water	Other Waters	4-day Average	Daily Average	1-hour Average	Instantaneous Maximum		4-day Average	Daily Average	1-hour Average
Methanes, halo-										
Methomyl										
Methoxychlor										
Methyl t-butyl ether (MTBE)										
4,4'-Methylene bis(N,N-dimethylaniline)										
Methyl ethyl ketone (MEK)										
Methyl methacrylate										
Methyl parathion										
Metolachlor										
Metribuzin										
Mirex										
Molinate										
Nabam										
Naphthalene										
Naphthalenes, chlorinated										
Nitralin										
Nitrobenzene										
Nitrofen										
Nitroguanidine										
2-Nitrophenol										
4-Nitrophenol										
Nitrophenol										
Nitrosamines										
N-Nitrosodi-n-butylamine										
N-Nitrosodiethanolamine										
N-Nitrosodiethylamine										
N-Nitrosodimethylamine										
N-Nitrosodiphenylamine										
N-Nitrosodipropylamine										
N-Nitroso-N-ethylurea										
N-Nitrosomethylethylamine										
N-Nitroso-N-methylurea										
N-Nitrosopyrrolidine										
trans-Nonachlor	0.00008 ‡ (82)	0.000081‡ (82)		0.0043 (82)			0.000081‡ (82)		0.0040 (82)	
Oil & grease										
Oxamyl										
Oxychlordane	0.00008 ‡ (82)	0.000081‡ (82)		0.0043 (82)			0.000081‡ (82)		0.0040 (82)	
PAHs										
Paraquat										
Parathion										
Pentachlorobenzene										
Pentachloroethane										
Pentachloronitrobenzene										
Pentachlorophenol	0.28 ‡	8.2 ‡	Varies with pH (13)		Varies with pH (11)		8.2 ‡	7.9		13
Phenanthrene	0.0028 ‡ (115)	0.031 ‡ (115)					0.031 ‡ (115)			
Phenol	300 (36)									
Phenols, chlorinated										
Phenols, nitro-										
Phenols, non-chlorinated										
Phorate										
Phthalate esters										
Picloram										
Polybrominated biphenyls										
Polychlorinated biphenyls	0.000070 ‡	0.000070 ‡		0.014			0.000070 ‡		0.030	
Prometon										
Pronamide										
Propachlor										
Propanes, dichloro-										
Propanil										
Propazine										

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WATER QUALITY GOALS — ORGANIC CONSTITUENTS

HEALTH AND AQUATIC LIFE — INLAND SURFACE WATERS AND ENCLOSED BAYS & ESTUARIES

ORGANIC CONSTITUENT	California Inland Surface Waters Plan Numerical Water Quality Objectives						California Enclosed Bays & Estuaries Plan Numerical Water Quality Objectives			
	Human Health Protection (30-day Average) "‡" - carcinogen		Freshwater Aquatic Life Protection				Human Health Protection (30-day Average) "‡" - carcinogen	Saltwater Aquatic Life Protection		
	Sources of Drinking Water	Other Waters	4-day Average	Daily Average	1-hour Average	Instantaneous Maximum		4-day Average	Daily Average	1-hour Average
Propenes, dichloro-										
Propham										
Pyrene	0.0028 ‡ (115)	0.031 ‡ (115)					0.031 ‡ (115)			
RDX (Cyclonite)										
Resorcinol										
Rotenone										
Simazine										
Styrene										
Sulfallate										
2,4,5-T										
2,3,7,8-TCDD (Dioxin)	0.000000013 ‡ (76)	0.000000014 ‡ (76)					0.000000014 ‡ (76)			
Tebuthiuron										
Terbacil										
Terbufos										
1,2,4,5-Tetrachlorobenzene										
1,1,1,2-Tetrachloroethane										
1,1,2,2-Tetrachloroethane										
Tetrachloroethylene (PCE)										
2,3,4,6-Tetrachlorophenol										
2,3,5,6-Tetrachlorophenol										
Thiobencarb										
Thiram										
Toluene	10,000	300,000					300,000			
Toxaphene	0.00067 ‡	0.00069 ‡	0.0002		0.73		0.00069 ‡	0.00002		0.21
2,4,5-TP (Silvex)										
Tributyltin			0.02 (61)	0.04		0.06	0.0050			
Trichloroacetaldehyde, hydrated										
Trichloroacetic acid										
Trichloroacetonitrile										
Trichlorfon										
1,2,4-Trichlorobenzene										
1,3,5-Trichlorobenzene										
1,1,1-Trichloroethane										
1,1,2-Trichloroethane										
Trichloroethylene (TCE)										
Trichlorofluoromethane										
2,4,5-Trichlorophenol										
2,4,6-Trichlorophenol	0.34 ‡	1.0 ‡					1.0 ‡			
1,2,3-Trichloropropane										
1,1,2-Trichloro-1,2,2-trifluoroethane										
Trifluralin										
Trinitroglycerol										
Trinitrophenol										
Trinitrotoluene (TNT)										
Trithion										
Urethane										
Vinyl chloride										
Xylene(s)										
Zineb										
Ziram										

Values are in µg/l (ppb) unless otherwise indicated. Numbers in parentheses indicate footnotes.

WATER QUALITY GOALS — ORGANIC CONSTITUENTS
MARINE RESOURCES

ORGANIC CONSTITUENT	California Ocean Plan Numerical Water Quality Objectives						U. S. EPA National Ambient Water Quality Criteria Saltwater Aquatic Life Protection						
	Human Health Protection (30-day Average) "‡" = carcinogen	Marine Aquatic Life Protection					Recommended Criteria				Toxicity Information		
		6-month Median	30-day Average	7-day Average	Daily Maximum	Instantaneous Maximum	Continuous Concentration (4-day Average)	24-hour Average	Maximum Concentration (1-hour Average)	Maximum	Acute	Chronic	Other
Acenaphthene											970	710	500 (38)
Acenaphthylene	0.0088 ‡ (115)												
Acetaldehyde											300 (41)		
Acifluorfen													
Acrolein	220										55		
Acrylamide													
Acrylonitrile	0.10 ‡												
Alachlor													
Aldicarb													
Aldicarb sulfone													
Aldicarb sulfoxide													
Aldrin	0.000022 ‡									1.3			
Ametryn													
Aniline													
Anthracene	0.0088 ‡ (115)										300 (41)		
Atrazine													
Azinphos-methyl										0.01			
Azobenzene													
Baygon													
Benefin													
Bentazon													
Benz(a)anthracene	0.0088 ‡ (115)										300 (41)		
Benzene	5.9 ‡										5100		700 (84)
Benzenes, chlorinated											160	129	
Benzenes, dichloro-											1970	129 (22)	
Benzenes, trichloro-											160 (22)	129 (22)	
Benzidine	0.000069 ‡												
Benzidines, dichloro-													
Benzo(b)fluoranthene	0.0088 ‡ (115)										300 (41)		
Benzo(k)fluoranthene	0.0088 ‡ (115)										300 (41)		
Benzo(g,h,i)perylene	0.0088 ‡ (115)										300 (41)		
Benzo(a)pyrene	0.0088 ‡ (115)										300 (41)		
alpha-BHC		0.004 (43)			0.008 (43)	0.012 (43)							
beta-BHC		0.004 (43)			0.008 (43)	0.012 (43)							
gamma-BHC (Lindane)		0.004 (43)			0.008 (43)	0.012 (43)				0.16			
delta-BHC		0.004 (43)			0.008 (43)	0.012 (43)							
technical-BHC		0.004 (43)			0.008 (43)	0.012 (43)					0.34		
Bis(2-chloroethyl) ether	0.045 ‡												
Bis(2-chloroethoxy) methane	4.4												
Bis(2-chloroisopropyl) ether	1200												
Bis(chloromethyl) ether													
Bromacil													
Bromochloromethane													
Bromodichloromethane	130 ‡ (113)										12,000 (20)	6400 (20)	11,500 (20,83)
Bromoform	130 ‡ (113)										12,000 (20)	6400 (20)	11,500 (20,83)
Bromomethane	130 ‡ (113)										12,000 (20)	6400 (20)	11,500 (20,83)
4-Bromophenyl phenyl ether													
Butachlor													
1,3-Butadiene													
Butylate													
n-Butyl benzyl phthalate											2944 (45)		3.4 (38,45)
Captan													
Carbaryl													
Carbofuran													
Carbon tetrachloride	0.90 ‡										50000	6400 (20)	11,500 (20,83)
Carboxin													
Catechol		30 (86)			120 (86)	300 (86)							
Chloramben													
Chlordane	0.0000023‡ (82)							0.004		0.09			
Chlorobenzene	570										160 (22)	129 (22)	

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WATER QUALITY GOALS - ORGANIC CONSTITUENTS
MARINE RESOURCES

ORGANIC CONSTITUENT	California Ocean Plan Numerical Water Quality Objectives						U. S. EPA National Ambient Water Quality Criteria Saltwater Aquatic Life Protection						
	Human Health Protection (30-day Average) "‡" = carcinogen	Marine Aquatic Life Protection					Recommended Criteria				Toxicity Information		
		6-month Median	30-day Average	7-day Average	Daily Maximum	Instantaneous Maximum	Continuous Concentration (4-day Average)	24-hour Average	Maximum Concentration (1-hour Average)	Maximum	Acute	Chronic	Other
4-Chloro-o-cresol		1 (87)			4 (87)	10 (87)							
4-Chloro-m-cresol		1 (87)			4 (87)	10 (87)							
6-Chloro-m-cresol		1 (87)			4 (87)	10 (87)							
Chloroform	130 ‡										12,000 (20)	6400 (20)	11,500 (20,83)
Chloromethane	130 ‡ (113)										12,000 (20)	6400 (20)	11,500 (20,83)
2-Chloronaphthalene											7.5 (48)		
2-Chlorophenol		1 (87)			4 (87)	10 (87)							
3-Chlorophenol		1 (87)			4 (87)	10 (87)							
4-Chlorophenol		1 (87)			4 (87)	10 (87)					29700		
Chloropicrin													
3-Chloropropene													
Chlorothalonil													
2-Chlorotoluene													
4-Chlorotoluene													
Chlorpropham													
Chlorpyrifos							0.0056		0.011				
Chrysene	0.0088 ‡ (115)										300 (41)		
Cyanazine													
2,4-D													
Dacthal (DCPA)													
Dalapon													
DBCP													
DDD	0.00017 ‡ (50)							0.001 (50)		0.13 (50)	3.6		
DDE	0.00017 ‡ (50)							0.001 (50)		0.13 (50)	14		
DDT	0.00017 ‡ (50)							0.001 (50)		0.13 (50)			
Demeton										0.1			
Diazinon													
Dibenz(a,h)anthracene	0.0088 ‡ (115)										300 (41)		
Dibromoacetonitrile													
Dibromochloromethane	130 ‡ (113)										12,000 (20)	6400 (20)	11,500 (20,83)
Dibutyl phthalate	3500										2944 (45)		3.4 (38,45)
Dicamba													
Dichloroacetic acid													
Dichloroacetonitrile													
1,2-Dichlorobenzene	5100 (77)										1970 (24)	129 (22)	
1,3-Dichlorobenzene	5100 (77)										1970 (24)	129 (22)	
1,4-Dichlorobenzene	18 ‡										1970 (24)	129 (22)	
3,3'-Dichlorobenzidine	0.0081 ‡												
Dichlorodifluoromethane											12,000 (20)	6400 (20)	11,500 (20,83)
1,1-Dichloroethane													
1,2-Dichloroethane	130 ‡										113000		
1,1-Dichloroethylene	7100										224,000 (27)		
cis-1,2-Dichloroethylene											224,000 (27)		
trans-1,2-Dichloroethylene											224,000 (27)		
Dichloromethane	450 ‡										12,000 (20)	6400 (20)	11,500 (20,83)
2,3-Dichlorophenol		1 (87)			4 (87)	10 (87)							
2,4-Dichlorophenol		1 (87)			4 (87)	10 (87)							
2,5-Dichlorophenol		1 (87)			4 (87)	10 (87)							
2,6-Dichlorophenol		1 (87)			4 (87)	10 (87)							
3,4-Dichlorophenol		1 (87)			4 (87)	10 (87)							
1,2-Dichloropropane											10,300 (28)	3040 (28)	
1,3-Dichloropropene	8.9 ‡										790 (29)		
Dichlorvos													
Dieldrin	0.000040 ‡							0.0019		0.71			
Diesel Oil													
Di(ethylhexyl) adipate													
Di(2-ethylhexyl)phthalate	3.5 ‡						360 (100)		400 (100)		2,944 (45)		3.4 (38,45)
Diethyl phthalate	33000										2,944 (45)		3.4 (38,45)
Diisopropyl methyl phosphonate													
Dimethoate													

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WATER QUALITY GOALS - ORGANIC CONSTITUENTS
MARINE RESOURCES

ORGANIC CONSTITUENT	California Ocean Plan Numerical Water Quality Objectives						U. S. EPA National Ambient Water Quality Criteria Saltwater Aquatic Life Protection						
	Human Health Protection (30-day Average) "‡" = carcinogen	Marine Aquatic Life Protection					Recommended Criteria				Toxicity Information		
		6-month Median	30-day Average	7-day Average	Daily Maximum	Instantaneous Maximum	Continuous Concentration (4-day Average)	24-hour Average	Maximum Concentration (1-hour Average)	Maximum	Acute	Chronic	Other
Dimethrin													
2,4-Dimethylphenol		30 (86)			120 (86)	300 (86)							
Dimethyl phthalate	820000										2,944 (45)		3.4 (38,45)
1,3-Dinitrobenzene													
2,4-Dinitro-o-cresol	220	30 (86)			120 (86)	300 (86)					4850 (88)		
Dinitrophenol		30 (86)			120 (86)	300 (86)					4850 (88)		
2,4-Dinitrophenol	4	30 (86)			120 (86)	300 (86)					4850 (88)		
2,4-Dinitrotoluene	2.6 ‡										590 (53)		370 (53,83)
2,6-Dinitrotoluene											590 (53)		370 (53,83)
Dinoseb													
Di(n-octyl) phthalate											2,944 (45)		3.4 (38,45)
1,4-Dioxane													
Diphenamid													
1,2-Diphenylhydrazine	0.16 ‡												
Diquat													
Disyston													
Diuron													
Endosulfan		9 (42)			18 (42)	27 (42)		0.0087		0.034			
Endosulfan sulfate		9 (42)			18 (42)	27 (42)		0.0087 (104)					
Endothall													
Endrin		0.002			0.004	0.006		0.0023		0.037			
Epichlorohydrin													
Ethers, chloroalkyl-													
Ethers, halo-													
Ethion													
Ethylbenzene	4100										430		
Ethylene dibromide (EDB)													
Ethylene glycol													
Ethylene oxide (ETO)													
Ethylenes, dichloro-											224000		
Ethylene thiourea (ETU)													
Fenamiphos													
Ferbam													
Fluometuron													
Fluoranthene	15										40	16	
Fluorene	0.0088 ‡ (115)										300 (41)		
Folpet													
Fonofos													
Formaldehyde													
Furmecyclox													
Glyphosate													
Heptachlor	0.00072‡ (114)							0.0036		0.053			
Heptachlor epoxide	0.00072‡ (114)							0.0036 (8)					
Hexachlorobenzene	0.00021 ‡										160 (22)	129 (22)	
Hexachlorobutadiene	14 ‡										32		
Hexachlorocyclopentadiene	58										7		
Hexachloroethane	2.5 ‡										940		
Hexachlorophene													
n-Hexane													
Hexazinone													
HMX													
Indeno(1,2,3-c,d)pyrene	0.0088 ‡ (115)										300 (41)		
Isophorone	150,000										12900		
Isopropanol													
Kepone													
Kerosene													
Malathion										0.1			
Maleic hydrazide													
Maneb													
MCPA													

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WATER QUALITY GOALS — ORGANIC CONSTITUENTS
MARINE RESOURCES

ORGANIC CONSTITUENT	California Ocean Plan Numerical Water Quality Objectives						U. S. EPA National Ambient Water Quality Criteria Saltwater Aquatic Life Protection						
	Human Health Protection (30-day Average) "‡" = carcinogen	Marine Aquatic Life Protection					Recommended Criteria				Toxicity Information		
		6-month Median	30-day Average	7-day Average	Daily Maximum	Instantaneous Maximum	Continuous Concentration (4-day Average)	24-hour Average	Maximum Concentration (1-hour Average)	Maximum	Acute	Chronic	Other
Methanes, halo-	130 ‡ (113)										12000	6400	11,500 (83)
Methomyl													
Methoxychlor										0.03			
Methyl t-butyl ether (MTBE)													
4,4'-Methylene bis(N,N-dimethylaniline)													
Methyl ethyl ketone (MEK)													
Methyl methacrylate													
Methyl parathion													
Metolachlor													
Metribuzin													
Mirex										0.001			
Molinate													
Nabam													
Naphthalene											2350		
Naphthalenes, chlorinated											7.5		
Nitralin													
Nitrobenzene	4.9										6680		
Nitrofen													
Nitroguanidine													
2-Nitrophenol		30 (86)			120 (86)	300 (86)					4850 (88)		
4-Nitrophenol		30 (86)			120 (86)	300 (86)					4850 (88)		
Nitrophenol		30 (86)			120 (86)	300 (86)					4850 (88)		
Nitrosamines											3300000		
N-Nitrosodi-n-butylamine											3,300,000 (56)		
N-Nitrosodiethanolamine													
N-Nitrosodiethylamine											3,300,000 (56)		
N-Nitrosodimethylamine	7.3 ‡										3,300,000 (56)		
N-Nitrosodiphenylamine	2.5 ‡										3,300,000 (56)		
N-Nitrosodipropylamine											3,300,000 (56)		
N-Nitroso-N-ethylurea													
N-Nitrosomethylethylamine													
N-Nitroso-N-methylurea													
N-Nitrosopyrrolidine											3,300,000 (56)		
trans-Nonachlor	0.000023‡ (82)												
Oil & grease			25000	40000		75000							
Oxamyl													
Oxychlordane	0.000023 ‡ (82)												
PAHs	0.0088 ‡ (115)										300		
Paraquat													
Parathion													
Pentachlorobenzene											160 (22)	129 (22)	
Pentachloroethane											390	281	
Pentachloronitrobenzene													
Pentachlorophenol		1 (87)			4 (87)	10 (87)	7.9		13				
Phenanthrene	0.0088 ‡ (115)						4.6 (100)		7.7 (100)		300 (41)		
Phenol		30 (86)			120 (86)	300 (86)					5800		
Phenols, chlorinated		1			4	10							
Phenols, nitro-		30 (86)			120 (86)	300 (86)					4850		
Phenols, non-chlorinated		30			120	300							
Phorate													
Phthalate esters											2944		3.4 (38,45)
Picloram													
Polybrominated biphenyls													
Polychlorinated biphenyls	0.000019 ‡							0.03			>10		
Prometon													
Pronamide													
Propachlor													
Propanes, dichloro-											10300	3040	
Propanil													
Propazine													

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WATER QUALITY GOALS - ORGANIC CONSTITUENTS
MARINE RESOURCES

ORGANIC CONSTITUENT	California Ocean Plan Numerical Water Quality Objectives						U. S. EPA National Ambient Water Quality Criteria Saltwater Aquatic Life Protection						
	Human Health Protection (30-day Average) "‡" = carcinogen	Marine Aquatic Life Protection					Recommended Criteria				Toxicity Information		
		6-month Median	30-day Average	7-day Average	Daily Maximum	Instantaneous Maximum	Continuous Concentration (4-day Average)	24-hour Average	Maximum Concentration (1-hour Average)	Maximum	Acute	Chronic	Other
Propenes, dichloro-											790		
Propham													
Pyrene	0.0088 ‡ (115)										300 (41)		
RDX (Cyclonite)													
Resorcinol		30 (86)			120 (86)	300 (86)							
Rotenone													
Simazine													
Styrene													
Sulfallate													
2,4,5-T													
2,3,7,8-TCDD (Dioxin)	0.0000000039 ‡ (76)												
Tebuthiuron													
Terbacil													
Terbufos													
1,2,4,5-Tetrachlorobenzene											160 (22)	129 (22)	
1,1,1,2-Tetrachloroethane													
1,1,2,2-Tetrachloroethane	1200										9020		
Tetrachloroethylene (PCE)	99 ‡										10200	450	
2,3,4,6-Tetrachlorophenol		1 (87)			4 (87)	10 (87)							
2,3,5,6-Tetrachlorophenol		1 (87)			4 (87)	10 (87)					440		
Thiobencarb													
Thiram													
Toluene	85000										6300	5000	
Toxaphene	0.00021 ‡						0.0002		0.21				
2,4,5-TP (Silvex)													
Tributyltin	0.0014									0.010 (8)			
Trichloroacetaldehyde, hydrated													
Trichloroacetic acid													
Trichloroacetonitrile													
Trichlorfon													
1,2,4-Trichlorobenzene											160 (22)	129 (22)	
1,3,5-Trichlorobenzene													
1,1,1-Trichloroethane	540000										31200		
1,1,2-Trichloroethane	43000												
Trichloroethylene (TCE)	27 ‡										2000		
Trichlorofluoromethane											12,000 (20)	6400 (20)	11,500 (20,83)
2,4,5-Trichlorophenol		1 (87)			4 (87)	10 (87)	11 (100)		240 (100)				
2,4,6-Trichlorophenol	0.29 ‡	1 (87)			4 (87)	10 (87)							
1,2,3-Trichloropropane													
1,1,2-Trichloro-1,2,2 trifluoroethane													
Trifluralin													
Trinitroglycerol													
Trinitrophenol		30 (86)			120 (86)	300 (86)					4850 (88)		
Trinitrotoluene (TNT)													
Trithion													
Urethane													
Vinyl chloride	36 ‡												
Xylene(s)													
Zineb													
Ziram													

Values are in µg/l (ppb) unless otherwise indicated. Numbers in parentheses indicate footnotes.

FOOTNOTES

(7-day) For exposure of 7 days or less.
(10-day) For exposure of 10 days or less.
(24-hr) For exposure of 24 hours or less.
(7-yr) For "longer-term" exposure (7 years or less, EPA).

(A) Known human carcinogen; sufficient epidemiologic evidence in humans.
(B1) Probable human carcinogen; limited epidemiologic evidence in humans.
(B2) Probable human carcinogen; sufficient evidence from animal studies; no or inadequate human data.
(C) Possible human carcinogen; limited evidence from animal studies; no human data.
(D) Not classified as to human carcinogenicity; no data or inadequate evidence.
(E) Evidence of non-carcinogenicity for humans.

(1) For hardness in mg/l as CaCO3, criterion = e(0.8473[ln(hardness)]+0.8604) µg/l; see Inorganics pages 7 & 14.
(2) Value based on hardness of 40 mg/l; value increases with increasing hardness.
(3) Varies from 1.4 to 2.4 mg/l with air temperature; see Title 22, CCR, §64435, Table 4.
(4) For dissolved chloride associated with sodium; criterion probably will not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium.
(5) Based on reproductive toxicity.
(6) Pentavalent arsenic [As(V)] effects on plants.
(7) Calculated for child / for adult.
(8) Advisory; Reference 11.
(9) For hardness in mg/l as CaCO3, criterion = e(0.8473[ln(hardness)]+0.7614) µg/l; see Inorganics pages 7 & 14.
(10) For hardness in mg/l as CaCO3, criterion = e(0.7852[ln(hardness)]–3.490) µg/l; see Inorganics pages 7 & 8.
(11) Criterion = e[1.005(pH)–4.830] µg/l; criterion = 20 µg/l at pH 7.8.
(12) Value developed for chromium VI; may be applied to total chromium if valence unknown.
(13) Criterion = e[1.005(pH)–5.290] µg/l; criterion = 13 µg/l at pH 7.8.
(14) Calculated from CCR, Title 22, Division2, Articles 7 and 8 regulatory levels assuming 2 liters/day water consumption; cancer risk unless otherwise footnoted.
(15) Determined by CA Health & Welfare Agency regulation not to pose a risk of cancer through ingestion.
(16) Toxicity to one species of fish after 2600 hours of exposure.
(17) Mortality in a fish species after 30 day exposure.
(18) Estimated protective value; Reference 11.
(19) For total trihalomethanes (sum of bromoform, bromodichloromethane, chloroform & dibromochloromethane); based largely on technology and economics.
(20) For sum of halomethanes.
(21) Based on limited evidence.
(22) For sum of chlorinated benzenes.
(23) Toxicity to a fish species exposed for 7.5 days.
(24) For sum of dichlorobenzenes.
(25) 1983 SNARL; to be reviewed in the future.
(26) National Ambient Water Quality Criterion; Reference 13.
(27) For sum of dichloroethylenes.
(28) For sum of dichloropropanes.
(29) For sum of dichloropropenes.
(30) For sum of heptachlor and heptachlor epoxide.
(31) Adverse behavioral effects occur to one species.
(32) As CaCO3; minimum criterion except where natural conditions are less.
(33) For hardness in mg/l as CaCO3, criterion = e(1.128[ln(hardness)]–3.828) µg/l; see Inorganics pages 7 & 8.
(34) Flavor impairment in a fish species occurs.
(35) Mortality to early life stages of a fish species occurs.
(36) Based on organoleptic considerations (taste, odor, color, laundry staining, etc.)
(37) For sum of mononitrophenols.
(38) Toxicity to algae occurs.
(39) For chlorinated systems.
(40) For white phosphorus.
(41) For sum of polynuclear aromatic hydrocarbons.
(42) For the sum of endosulfan-alpha and -beta and endosulfan sulfate.
(43) For sum of benzene hexachloride isomers.
(44) Calculated from corn oil gavage animal study / from drinking water animal study.
(45) For sum of phthalate esters.
(46) For sum of chloroalkyl ethers.
(47) For sum of tetrachloroethanes.
(48) For sum of chlorinated naphthalenes.
(49) For hardness in mg/l as CaCO3, criterion = e(1.72[ln(hardness)]–6.52) µg/l; see Inorganics pages 7 & 13.
(50) For sum of DDT, DDD, and DDE.
(51) Based on exposure through water only / through water and fish; Reference 11.
(52) For sum of dichlorobenzidines.
(53) For sum of dinitrotoluenes.
(54) From Reference 15.
(55) For hardness in mg/l as CaCO3, criterion = e(0.8190[ln(hardness)]+1.561) µg/l; see Inorganics pages 7 & 9.
(56) For sum of nitrosamines.
(57) Guidance level; Reference 3; assumes relative source contribution of 10% from drinking water.
(58) For sum of haloethers.
(59) Chronic SNARL was estimated to be 100-fold lower than the listed 24-hour value in calculating this level.
(60) For hardness in mg/l as CaCO3, criterion = e(0.8190[ln(hardness)]+3.688) µg/l; see Inorganics pages 7 & 9.
(61) 6-month median.
(62) For pH between 6.5 and 9.0.
(63) For hardness in mg/l as CaCO3, criterion = e(0.8545[ln(hardness)]–1.465) µg/l; see Inorganics pages 7 & 10.
(64) Based on kepone.
(65) For hardness in mg/l as CaCO3, criterion = e(0.9422[ln(hardness)]–1.464) µg/l; see Inorganics pages 7 & 10.
(66) For hardness in mg/l as CaCO3, criterion = e(1.273[ln(hardness)]–4.705) µg/l; see Inorganics pages 7 & 11.
(67) For hardness in mg/l as CaCO3, criterion = e(1.273[ln(hardness)]–1.460) µg/l; see Inorganics pages 7 & 11.
(68) Draft / tentative / provisional.
(69) For Arochlor 1260.
(70) At pH 6.8, caused 50% reduction in growth of yearling sockeye salmon in 56-day test.
(71) May be present as a decomposition product in Ferbam, Maneb, Nabam, Thiram, Zineb, and Ziram.
(72) As NO3.
(73) Recommended level; Upper level = 500 mg/l; Short-term level = 600 mg/l.
(74) Recommended level; Upper level = 1600; Short-term level = 2200.
(75) Recommended level; Upper level = 1000; Short-term level = 1500 mg/l.
(76) For "TCDD equivalents" calculated as the sum of 2,3,7,8-chlorinated dibenzodioxin and dibenzofuran concentrations multiplied by their respective U.S. EPA Toxicity Equivalency Factors.
(77) For sum of 1,2- and 1-3-dichlorobenzenes.
(78) Reference 15 unless noted otherwise.
(79) For elemental phosphorus; marine or estuarine.
(80) Instantaneous maximum.
(81) For hardness in mg/l as CaCO3, criterion = e(0.8460[ln(hardness)]+1.1645) µg/l; see Inorganics pages 7 & 12.
(82) For the sum of oxychlordane and alpha and gamma isomers of chlordane, chlordene and nonachlor.
(83) A decrease in the number of algal cells occurs.
(84) Adverse effects on a fish species exposed for 168 days.
(85) For hardness in mg/l as CaCO3, criterion = e(0.8460[ln(hardness)]+3.3612) µg/l; see Inorganics pages 7 & 12.
(86) For sum of nonchlorinated phenolic compounds.
(87) For sum of chlorinated phenolic compounds.
(88) For sum of nitrophenols.
(89) Expressed as nitrogen.
(90) For total chlorine residual; for intermittent chlorine sources see Reference 20, Chapter IV, Table B.
(91) See Reference 13.
(92) For sum of 3,3'-Dichlorobenzidine and its salts.
(93) Effective 30 July 1992.
(94) For the trivalent form.
(95) For the pentavalent form.
(96) EC50 for eastern oyster embryos.
(97) Varies with pH and temperature; see Inorganics Page 5 to select water quality goal.
(98) For total residual chlorine.
(99) For sum of chlorine-produced oxidants.
(100) Proposed.
(101) 7,000,000 fibers/liter; limited to fibers longer than 10 µm.
(102) Recommended level; not yet formally proposed.
(103) As nitrogen; in addition, MCL for total nitrate and nitrite = 10,000 µg/l (as N).
(104) Based on endosulfan; Reference 11.
(105) Value based on drinking water treatment technique; effective 30 July 1992; see Reference 2.
(106) As decachlorobiphenyl; effective 30 July 1992.
(107) Effective 1 January 1993.
(108) For molecules with 60 percent chlorine or greater by molecular weight.
(109) MCL varies with air temperature; ≤ 53.7 °F - 2.4 mg/l; 53.8 to 58.3 °F - 2.2 mg/l; 58.4 to 63.8 °F - 2.0 mg/l; 63.9 to 70.6 °F - 1.8 mg/l; 70.0 to 79.2 °F - 1.6 mg/l 79.3 to 90.5 °F - 1.4 mg/l.
(110) Includes Radium 226 but excludes Radon and Uranium.
(111) Effective 7 December 1992; "Action level" to be exceeded in no more than 10 percent of samples.
(112) Unionized ammonia concentrations; criteria based on total ammonia are shown on Inorganics page 6.
(113) For sum of bromoform, bromomethane, chloromethane, dibromochloromethane, and bromodichloromethane.
(114) As CaCO3; minimum concentration except where natural concentrations are less.
(115) For sum of acenaphthylene, anthracene, benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluorene, indeno(1,2,3-c,d)pyrene, phenanthrene, and pyrene.
(116) Effective 7 December 1992.

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2. U. S. Environmental Protection Agency, 40 Code of Federal Regulations, Parts 141 and 143.

3. U. S. Environmental Protection Agency, Office of Drinking Water, "Drinking Water Regulations and Health Advisories" (April 1991).

4. U. S. Environmental Protection Agency, Region 9, Drinking Water Branch, "Drinking Water Standards and Health Advisory Table" (August 1991).

5. U. S. Environmental Protection Agency, Federal Register, Volume 56, No. 110 (Friday, 7 June 1991), pages 26460-26564. Corrected in FR, Vol. 56, No. 135 (Mon., 15 July 1991) pages 32112-32113.

6. U. S. Environmental Protection Agency, Federal Register, Volume 56, No. 126 (Monday, 1 July 1991), pages 30266-30281.

7. U. S. Environmental Protection Agency, Federal Register, Volume 56, No. 138 (Thursday, 18 July 1991), pages 33050-33127.

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8. California Department of Health Services, Office of Drinking Water, "Summary: Maximum Contaminant Levels (MCLs) and Action Levels (ALs)" (18 October 1990).

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References 3 and 4.

9. U. S. Environmental Protection Agency, Office of Drinking Water "Health Advisory" documents (various dates).

10. 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).

11. U. S. Environmental Protection Agency, "Water Quality Advisory" documents (March 1986, September 1987).

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12. Criteria calculated from doses established by CA Department of Health Services (DHS), California Code of Regulations, Title 22, Division 2, Chapter 3, Articles 7 and 8, using procedures recommended by DHS.

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13. U. S. Environmental Protection Agency, "Quality Criteria for Water, 1986" (May 1986) plus updates (various dates).

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References 11 and 13.

16. U. S. Environmental Protection Agency, "Water Quality Criteria, 1972" (1973)

17. U. S. Environmental Protection Agency, Federal Register, Volume 55, No. 93, (Monday, 14 May 1990), pp. 19987-19992.

18. U. S. Environmental Protection Agency, "Ambient Water Quality Criteria" documents (various dates).

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19. California State Water Resources Control Board, "Water Quality Control Plan for Inland Surface Waters of California", Document 91-12 WQ, Chapter II (11 April 1991).

California Enclosed Bays and Estuaries Plan - Numerical Water Quality Objectives

20. California State Water Resources Control Board, "Water Quality Control Plan for Enclosed Bays and Estuaries of California", Document 91-13 WQ, Chapter II (11 April 1991).

California Ocean Plan - Numerical Water Quality Objectives

21. California State Water Resources Control Board, "Water Quality Control Plan: Ocean Waters of California", Chapter IV (22 March 1990).

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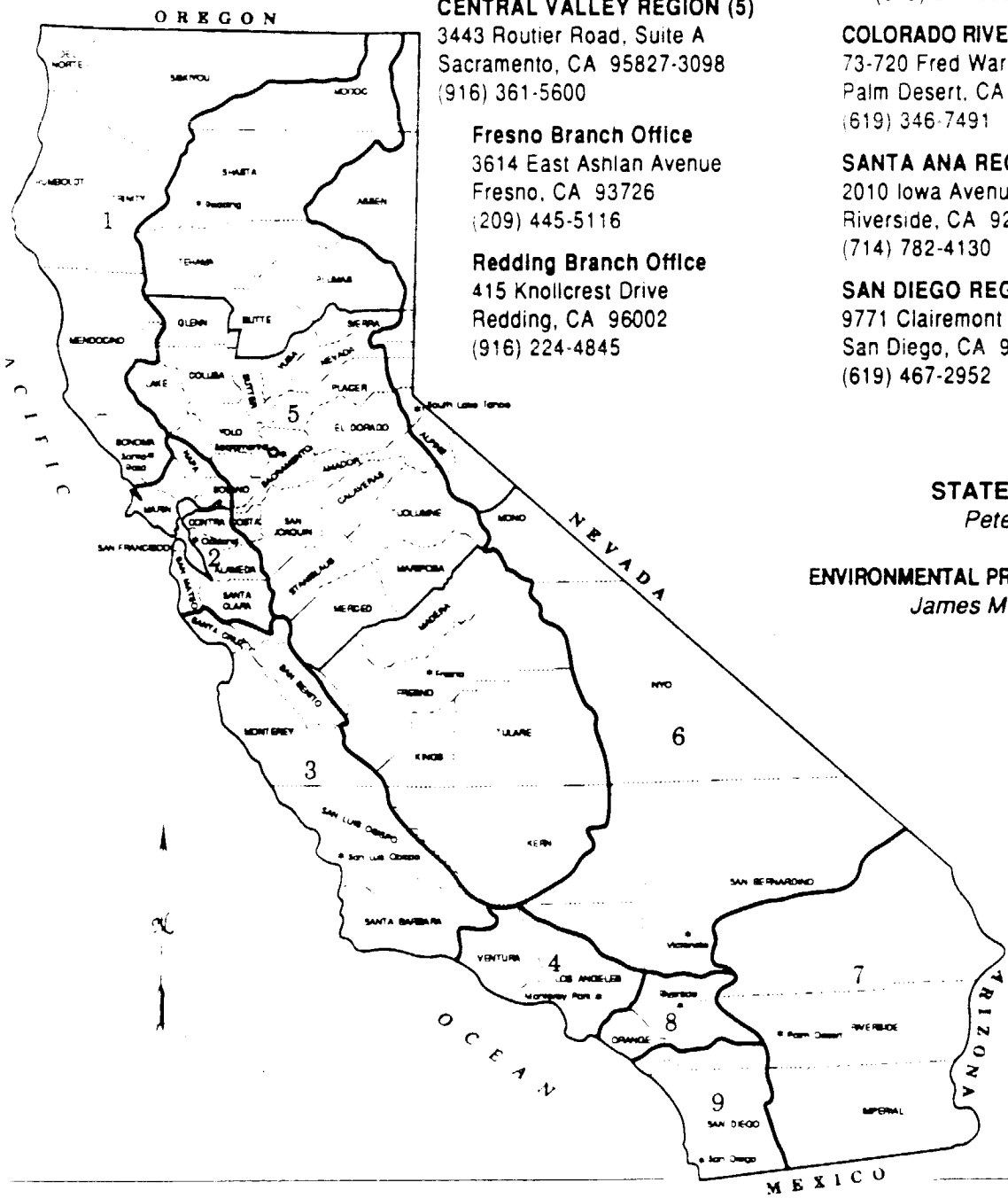

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ENVIRONMENTAL PROTECTION AGENCY
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1 June 1992