

Water Boards Training Academy
Course WQ120

Water Quality Goals

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Main Concepts

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- n How do we select numeric thresholds to assess our water resources?**

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 - u **Porter-Cologne Water Quality Control Act**
 - u **Water quality standards**
 - u **State & Regional Water Board plans & policies**



Main Concepts

- n **How do we select numeric thresholds to assess our water resources?**
 - u **Porter-Cologne Water Quality Control Act**
 - u **Water quality standards**
 - u **State & Regional Water Board plans & policies**

- n **How do antidegradation principles affect numeric threshold selection?**



What Will We Cover Today?

- n **Statutes, regulations plans & policies relating to water quality standards**
- n **Implementing narrative water quality objectives**
 - u **Using numeric thresholds from other organizations and the peer reviewed literature**
- n **Water quality goals**
 - u **Report**
 - u **Database and on-line resources**
- n **Algorithms to select water quality assessment thresholds**

**In California
water is a
limited and
valuable
resource**



Porter-Cologne Water Quality Control Act

Enacted by state legislature in 1969

**found in Division 7 of
the California Water Code**

n Legislative declarations



The Legislature Finds and Declares...

(Water Code §13000)



- n that the people of the state have a primary interest in the conservation, control, and utilization of the water resources of the state, and**
- n that the quality of all the waters of the state shall be protected for use and enjoyment by the people of the state**

The Legislature Finds and Declares...

(Water Code §13000) continued



- n that activities and factors which may affect the quality of the waters of the state shall be regulated to attain the **highest water quality which is reasonable**, considering all demands being made and to be made on those waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible.**

The Legislature Finds and Declares...

(Water Code §13000) continued



n that the state must be prepared to exercise its full power and jurisdiction to **protect the quality of waters in the state from degradation** originating inside or outside the boundaries of the state...

Water Quality Control

Water Code, Section 13050(i)

- n **The regulation of any activity or factor which may affect the quality of the waters of the state and includes the prevention and correction of water pollution and nuisance**

Pollution

Water Code, Section 13050(1)

- n An alteration of the quality of the waters of the state by waste to a degree which unreasonably affects either of the following**
 - u The waters for beneficial uses**
 - u Facilities which serve these beneficial uses**
- n Pollution may include “contamination”**

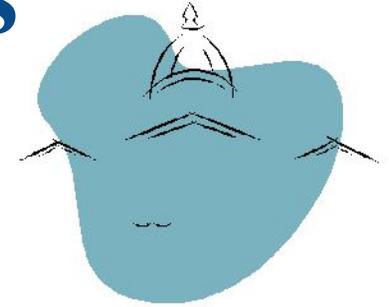
Nuisance

Water Code, Section 13050(m)

Anything which meets **all** of the following

- n Is injurious to health, or is indecent or offensive to the senses, or an obstruction to the free use of property,
 - u So as to interfere with the comfortable enjoyment of life or property
- n Affects at the same time an entire community or neighborhood, or any considerable number of persons
 - u Although the extent of the annoyance or damage inflicted upon individuals may be unequal
- n Occurs during, or as a result of, **the treatment or disposal of wastes**

Water Quality Standards



Federal Clean Water Act—

- n Provisions of state or federal law
- n **Designated use** or uses for waters of the United States and
- n **Water quality criteria** for such waters based upon such uses

[40 CFR 130.2(c) and 131.3(i)]

Water Quality Standards In California



- n Found in the
Water Quality
Control Plans
(Basin Plans)
- n Adopted by the
State and Regional
Water Boards



Water Quality Standards In California



Water Quality Standards include

- n Beneficial Use designations**
for each water body or portion thereof
- n Water Quality Objectives**
(criteria) to protect uses
- n Implementation Programs**
to achieve the objectives

Water Quality Standards In California



- n **“Waters of the state” include both surface waters and groundwaters**
 - u **Effectively, both have water quality standards**
- n **Water Quality Standards apply throughout the water body**
 - u **To protect existing and future uses**

Beneficial Uses of Waters of the State

California Water Code § 13050(f)

“Beneficial uses” of the waters of the state that may be protected against water quality degradation include, but are not necessarily limited to,

- u domestic, municipal, agricultural and industrial supply;**
- u power generation;**
- u recreation;**
- u esthetic enjoyment;**
- u navigation; and**
- u preservation and enhancement of fish, wildlife, and other aquatic resources or preserves.**

Present and Potential Beneficial Uses of Waters of the State

from the Water Quality Control Plans

- n **Municipal and Domestic Supply**
- n **Agricultural Supply**
- n **Industrial Supply**
 - u **Service Supply**
 - u **Process Supply**
- n **Groundwater Recharge**
- n **Freshwater Replenishment**
- n **Navigation**



Present and Potential Beneficial Uses of Waters of the State

n **Hydropower Generation**

n **Recreation**

u **Contact**

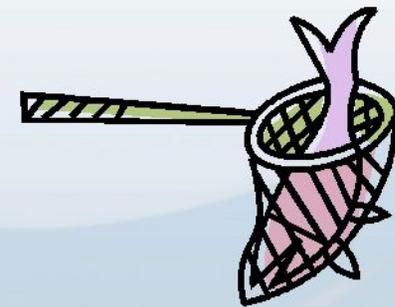
u **Non-contact**

n **Commercial & Sport Fishing**

n **Shellfish Harvesting**

n **Subsistence Fishing**

n **Aquaculture**

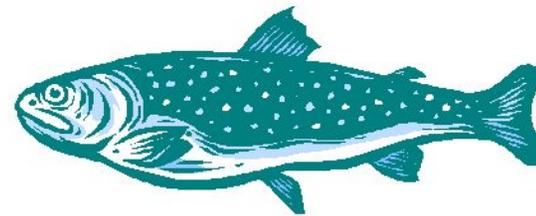


Present and Potential Beneficial Uses of Waters of the State

n Freshwater Habitat

- u Warm

- u Cold



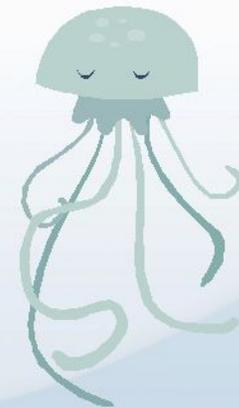
n Estuarine Habitat

n Inland Saline Water Habitat

n Marine Habitat

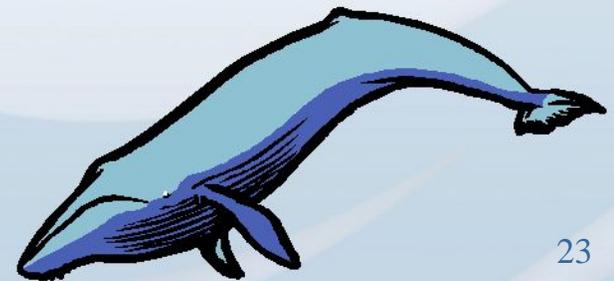
n Wetland Habitat

n Wildlife Habitat



Present and Potential Beneficial Uses of Waters of the State

- n **Preservation of Areas of Special Biological Significance**
- n **Preservation of Rare, Threatened, or Endangered Species**
- n **Migration of Aquatic Organisms**
- n **Spawning, Reproduction, and/or Early Development**



Present and Potential Beneficial Uses of Waters of the State

- n **Water Quality Enhancement**
- n **Flood Peak Attenuation/
Flood Water Storage**
- n **Native American Culture**



**State Water Resources Control Board
Resolution No. 88-63**



Adoption of a Policy Entitled “Sources of Drinking Water”

**“All surface and groundwaters
of the State are considered to
be suitable, or potentially
suitable, for municipal or
domestic water supply...”**



Sources of Drinking Water

Policy Exceptions

- n Waters with total dissolved solids (TDS) > 3,000 mg/L 
- n Waters with contamination, unrelated to a specific pollution incident, that cannot reasonably be treated for domestic use using best management practices or best economically achievable treatment practices

Sources of Drinking Water

Policy Exceptions

- n **Source cannot provide an average sustained yield of 200 gallons per day**
- n **Certain municipal, industrial, and agricultural wastewater conveyances and holding facilities**
- n **Regulated geothermal groundwaters**



Water Quality Objectives

Water Code §13050(h)

“Water quality objectives” means

n Limits or levels of water quality constituents or characteristics established for the

- u Reasonable protection of beneficial uses of water or the**
- u Prevention of nuisance within a specific area**

Water Quality Objectives

Come in two forms

n Numeric

u Specifies a concentration limit

n Narrative

**u Describes a requirement
or prohibits a condition
harmful to beneficial uses**

Numeric Water Quality Objectives

examples from the two Central Valley Region Basin Plans

- n Ammonia
- n Arsenic
- n Bacteria
- n Barium
- n Boron
- n Cadmium
- n Copper
- n Cyanide
- n Diazinon
- n Dissolved Oxygen
- n Iron
- n Manganese
- n Methyl-mercury
- n Molybdenum
- n pH
- n Salinity
 - u TDS & EC
- n Selenium
- n Silver
- n Temperature
- n Thiobencarb
- n Turbidity
- n Zinc

Narrative Water Quality Objectives

language from the Central Valley Region Basin Plans

n Chemical Constituents - General

- u Waters shall **not** contain chemical constituents in concentrations that **adversely affect beneficial uses**
- u **Example: Boron and agricultural use**



Narrative Water Quality Objectives

language from the Central Valley Region Basin Plans

n **Chemical Constituents - MCLs**

- u **At a minimum, waters designated for use as domestic or municipal supply shall not contain concentrations of chemical constituents in excess of California drinking water Maximum Contaminant Levels (MCLs)**
- u **To protect all beneficial uses the Regional Water Board may apply limits more stringent than MCLs**

Narrative Water Quality Objectives

language from the Central Valley Region Basin Plans

n Toxicity

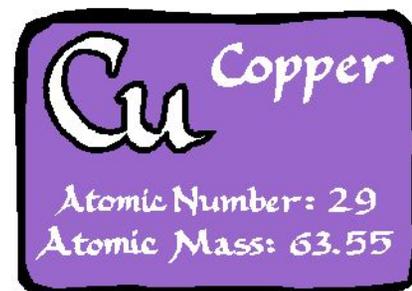
- u All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life
- u This objective applies regardless of whether the toxicity is caused by a single substance or the interactive effect of multiple substances



Narrative Water Quality Objectives

n Toxicity

u Example: Copper



Beneficial Use by	Toxicity Threshold	ug/L (ppb)
• Humans	MCL	1300
	PHG	300
• Fish	CTR	2.7 to 29
• Plants	Ag limit	200

Narrative Water Quality Objectives

language from the Central Valley Region Basin Plans

n Tastes & Odors

u Water shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes or odors

- to domestic or municipal water supplies or
- to fish flesh or other edible products of aquatic origin or
- that cause nuisance or
- otherwise adversely affect beneficial uses



Toxicity vs. Taste & Odor



**California
Primary
MCL**

**Taste & Odor
Threshold**

Ethylbenzene

300 ug/L

29 ug/L

Toluene

150 ug/L

42 ug/L

Xylenes

1750 ug/L

17 ug/L

MTBE

13 ug/L

5 ug/L

Narrative Water Quality Objectives

language from the Central Valley Region Basin Plans

n Pesticides

- u No pesticides in water, sediment or aquatic life in concentrations that adversely affect beneficial uses
- u Not exceed MCLs in waters designated MUN
- u No total persistent chlorinated hydrocarbon pesticides in detectable concentrations
- u Not to exceed lowest levels technically and economically achievable



Other Narrative WQ Objectives

examples from the Central Valley Region Basin Plans

- n **Biostimulatory Substances**
- n **Color**
- n **Floating Material**
- n **Oil and Grease**
- n **Radioactivity**
- n **Sediment**
- n **Settleable Material**
- n **Suspended Material**
- n **Temperature**
- n **Turbidity**

Let's Not Be Confused

Beneficial Uses – Water Rights

- n More limited definitions in Water Rights regulations relating to appropriation of water**
 - u Domestic**
 - u Irrigation**
 - u Power**
 - u Frost Protection**
 - u Municipal**
 - u Mining**
 - u Industrial**
 - u Fish and Wildlife Preservation and Enhancement**
- u Aquaculture**
- u Recreational**
- u Stockwatering**
- u Water Quality**
- u Frost Protection**
- u Heat Control**

[see Title 23, Division 3, Chapter 2, Article 2, Subarticle 2]

Special Water Quality Objectives

Differ from Basin Plan Objectives

- n Under its **Water Rights** authority **State Water Board** can adopt water quality objectives specifying flow or operational requirements related to appropriation of water for **beneficial uses**
 - u e.g., Bay-Delta Water Quality Control Plan
- n **State Water Board** can manage water rights to ensure these objectives are met
- n **Regional Water Boards** have no authority to implement these objectives
- n **USEPA** has no authority to approve these objectives under the **Clean Water Act**



Water Rights & Water Quality

- n Condition in every Water Rights permit**
 - u Pursuant to State Water Board adopted regulation**
- n State Water Board may modify quantity of water diverted**
 - u If necessary to meet water quality objectives in a Water Quality Control Plan (e.g., Basin Plan)**
 - u Required findings to modify water diversion**
 - Adequate Waste Discharge Requirements have been prescribed for all waste discharges**
 - Water quality objectives cannot be achieved solely through control of waste discharges**

California Toxics Rule (CTR)

- n **Federal Clean Water Act**
 - u All States required to have enforceable numeric water quality criteria for **priority toxic pollutants** in surface waters
- n **Statewide Water Quality Control Plans SWRCB**
 - u Inland Surface Waters Plan (1991)
 - u Enclosed Bays & Estuaries Plan (1991)
- n **National Toxics Rule (NTR) USEPA**
 - u Promulgated in 1992 (amended in 1995 & 1999)
 - u Criteria filled gaps in Statewide Plans

California Toxics Rule (CTR)

- n **Statewide Plans rescinded in 1994**
 - u **Court order from discharger lawsuit**
 - u **Adoption did not sufficiently consider economics**
- n **California out of compliance with CWA**
- n **California Toxics Rule USEPA**
 - u **Promulgated 18 May 2000 (amended Feb 2001)**
 - u **NTR criteria still in effect**
 - u **CTR criteria fill gaps in CWA compliance**

Enforceable Water Quality Standards



n Two scenarios in California

**Water Quality Objectives
+ Basin Plan Beneficial Use Designations**

**CTR and NTR Criteria
+ Basin Plan Beneficial Use Designations**

California Toxics Rule (CTR)

n *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries (SIP)*

u **SWRCB** adopted March 2000 (amended 2005)

- Time Schedules
- Mixing Zones
- Effluent Limits
- Water Effect Ratios
- Background Levels
- Analytical Methods
- Reporting Levels



California Toxics Rule (CTR)

- n State-adopted Site-specific Objectives**
 - u If approved by EPA, supersede NTR & CTR**
 - **Sacramento R. – upstream of Hamilton City**
 - ? **Copper, Cadmium, & Zinc objectives**
= acute exposure
 - ? **CTR chronic criteria also apply**
 - **San Francisco Bay – specific water bodies**
 - ? **Arsenic, Cyanide, Metals, Selenium objectives**
 - u If under EPA review, more stringent applies**

Implementation Procedures

“Numeric Translators”



n **Clean Water Act**

water quality standards

regulations and guidance require

- u **Implementation procedures to ensure that narrative criteria (objectives) for toxic pollutants are attained**
- u **Using chemical-specific controls**
- u **Including numeric criteria and permit limits**

Policy for Application of Water Quality Objectives

from the Implementation Chapter of the **Central Valley** Region Basin Plans

n Where and When Objectives Apply

- u In all waters where beneficial uses have been designated, **not just at current points of use**
 - To protect existing and future beneficial uses
- u **Mixing Zones may be designated for NPDES**
 - In a mixing zone, water quality objectives do not apply
 - Zone may not adversely affect beneficial uses
- u **Compliance Schedules may be allowed for new objectives in NPDES permits**
 - If infeasible to achieve immediate compliance

Policy for Application of Water Quality Objectives

from the Implementation Chapter of the **Central Valley** Region Basin Plans

- n **Numeric receiving water limitations will be established in Board orders for constituents and parameters which will, at a minimum, meet all applicable water quality objectives**
- n **The Board will impose more stringent numeric limitations or prohibitions to maintain the existing water quality unless some degradation is allowed pursuant to Resolution No. 68-16 (Antidegradation Policy)**

Policy for Application of Water Quality Objectives

from the Implementation Chapter of the **Central Valley** Region Basin Plans

n Narrative Objectives

- u Implement with numeric limits in orders
 - u Evaluate compliance by considering
 - Direct evidence of beneficial use impacts
 - All material and relevant information submitted by the discharger and other interested parties
 - Relevant numeric criteria and guidelines from other agencies and organizations
- ? see *“A Compilation of Water Quality Goals”*

Policy for Application of Water Quality Objectives

from the Implementation Chapter of the **Central Valley** Region Basin Plans

- n **Water quality objectives do not require improvement over natural background concentrations**
 - u **If Background > Water Quality Objective controllable water quality factors are not allowed to cause further degradation**
 - e.g., discharges of waste

Policy for Application of Water Quality Objectives

from the Implementation Chapter of the **Central Valley** Region Basin Plans

- n **Interaction of multiple toxic pollutants**
 - u **Assume additivity for carcinogens and substances with similar toxic effects**



Application of Water Quality Objectives

from the Implementation Chapter of the **San Francisco Bay** Region Basin Plan

- n **To evaluate compliance with water quality objectives, Board will consider**
 - u **All relevant and scientifically valid evidence**
 - u **Including numeric criteria and guidelines developed and/or published by other agencies and organizations**
 - Summarized in
“A Compilation of Water Quality Goals”

Minimum & Maximum Levels

n **Water Quality Objectives**

+ **CTR & NTR Criteria**

define the least stringent limits imposed on ambient water quality

n **Natural Background**

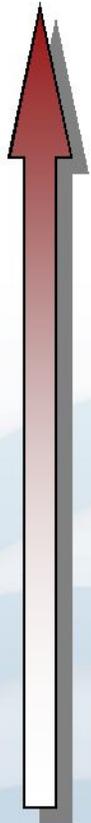
defines the most stringent limits imposed on ambient water quality

u **Controllable Factors Policies (Basin Plans)**

u **Antidegradation Policy (Res. 68-16)**

Appropriate Range of Water Quality to Protect Beneficial Uses

Increasing Concentrations



Water Quality Standards

- Water quality objectives
- CTR and NTR criteria

Natural Background Levels

“Zero”

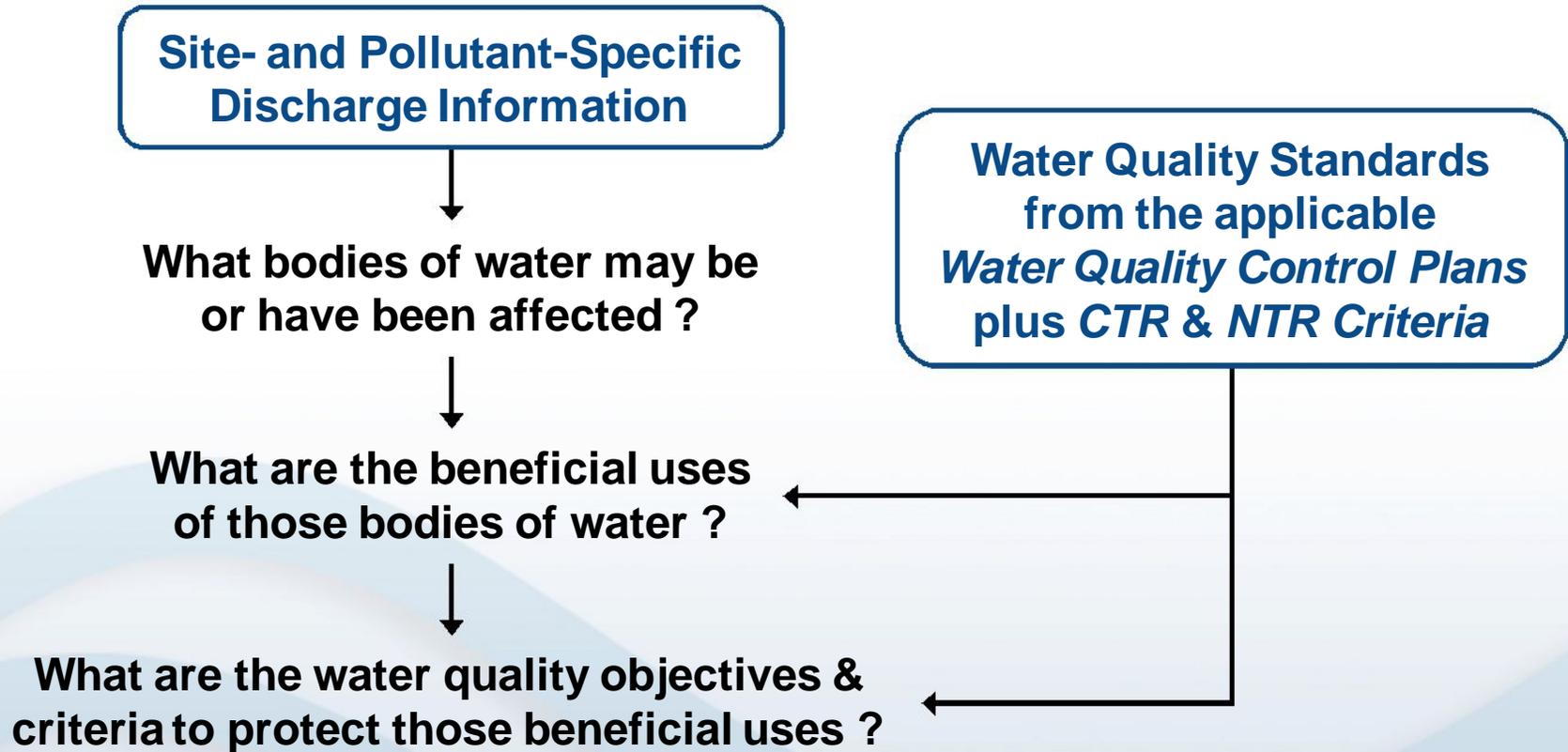
Selecting Assessment Thresholds

**Site- and Pollutant-Specific
Discharge Information**

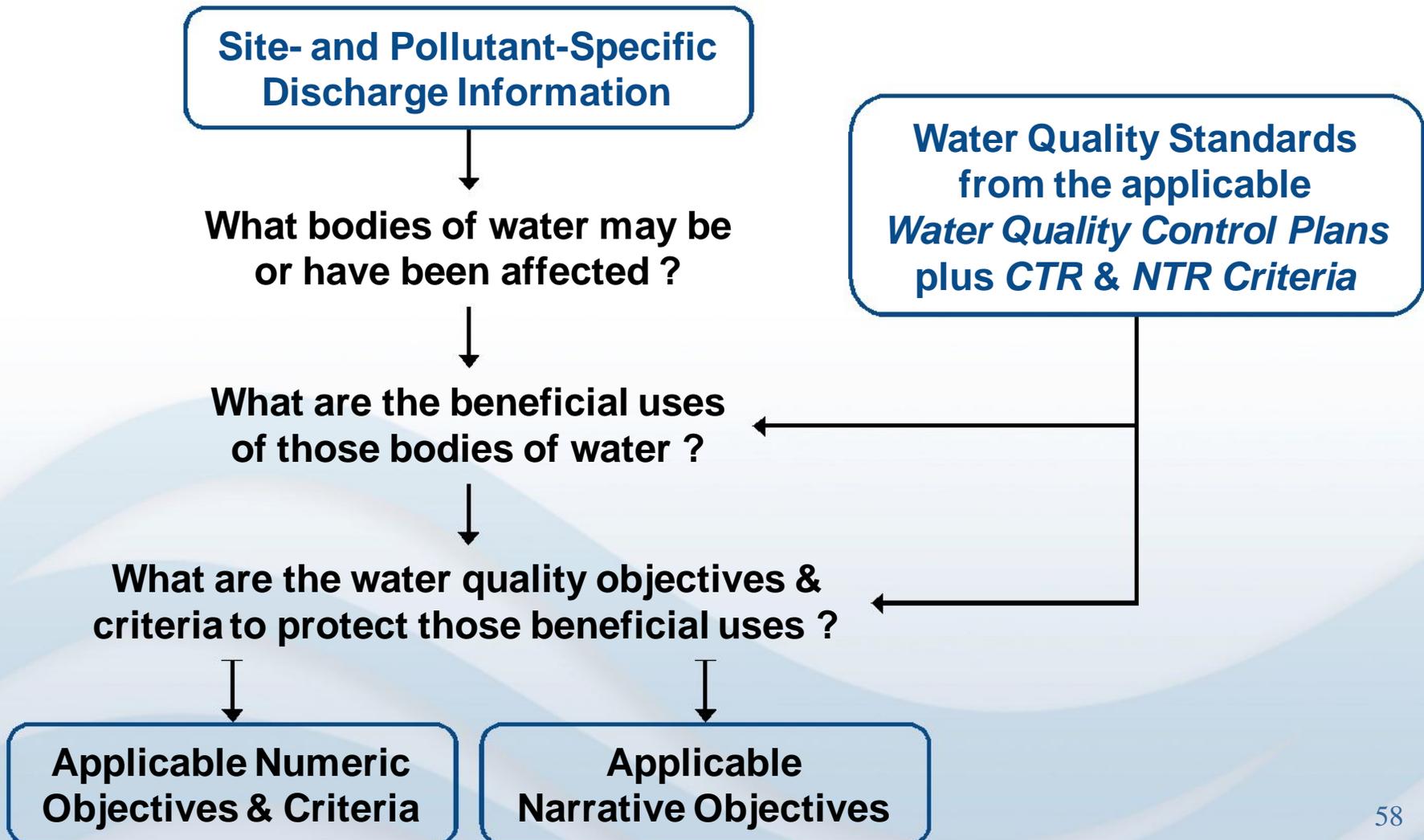


**What bodies of water may be
or have been affected ?**

Selecting Assessment Thresholds



Selecting Assessment Thresholds



Selecting Assessment Thresholds

**Applicable Numeric
Objectives & Criteria**

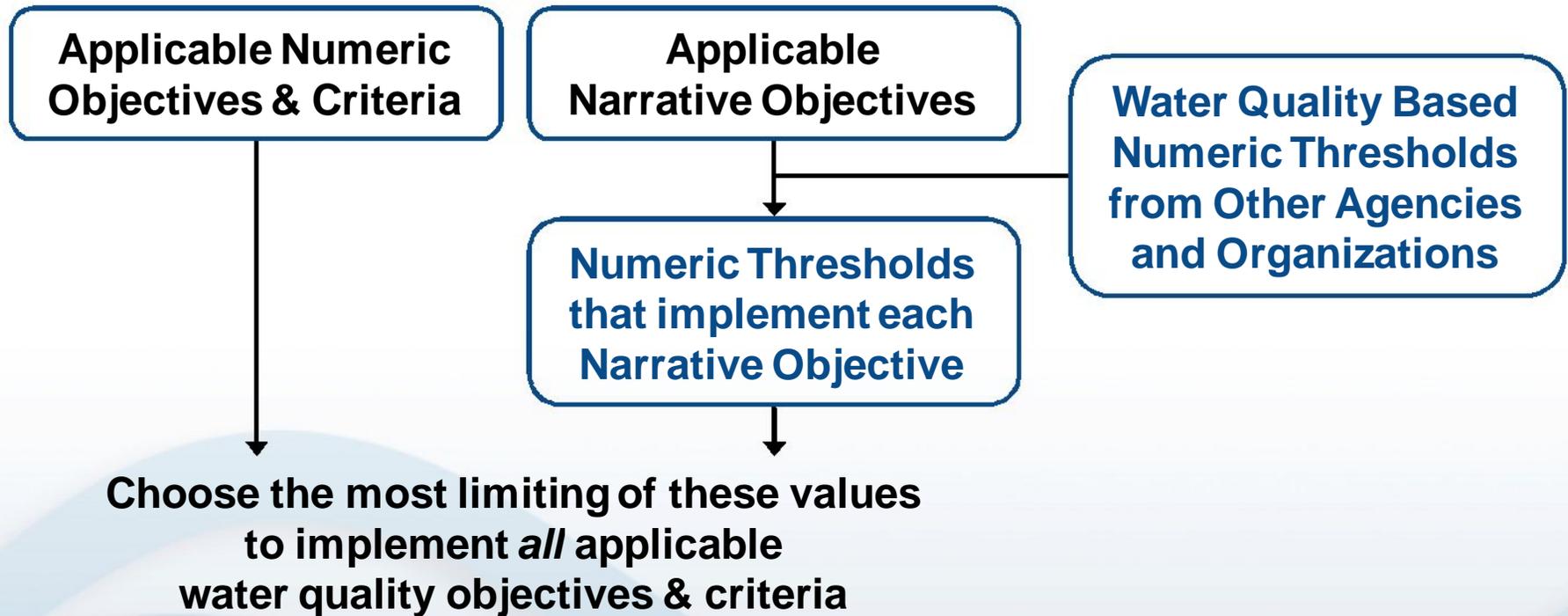
**Applicable
Narrative Objectives**

Selecting Assessment Thresholds

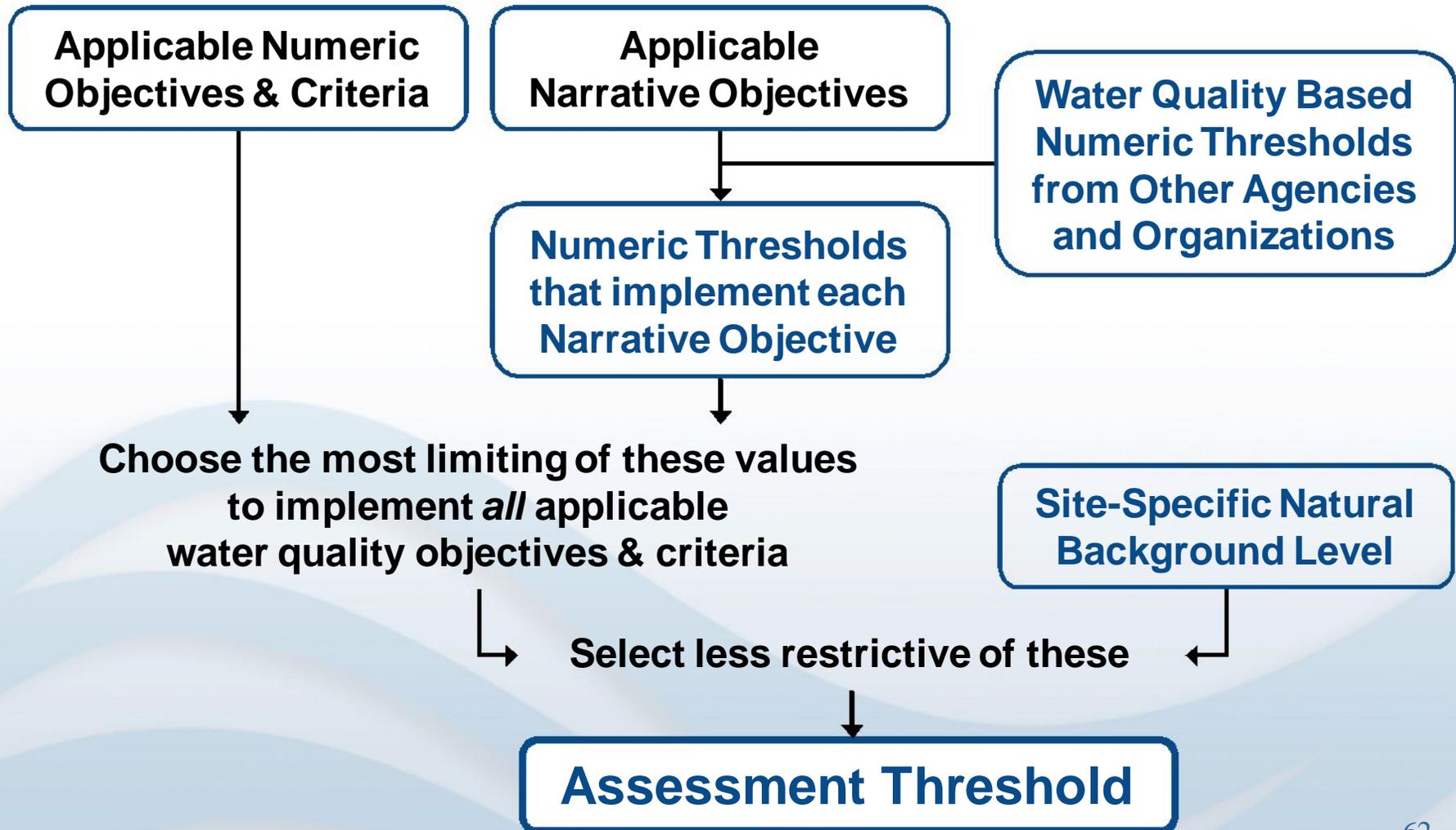
**Applicable Numeric
Objectives & Criteria**

**Applicable
Narrative Objectives**

Selecting Assessment Thresholds



Selecting Assessment Thresholds



Let's Take a Break



Sources of Numeric Thresholds

Used to Implement Narrative Objectives

Chemical Constituents objective

- n **California Drinking Water MCLs** **CDPH**
 - u Primary MCLs based on human health
 - u Secondary MCLs based on human welfare
 - u Technology & Economics of water use at the tap
- n **Federal Drinking Water MCLs** **USEPA**
 - u Only if < CA MCLs (future use)
- n ***Water Quality for Agriculture*** **FAO-UN**
- n ***Water Quality Criteria*** (McKee & Wolf) **SWRCB**
 - u e.g., industrial use criteria

MCLs Are Not Always Sufficient to Implement the Narrative Toxicity Objective

- n **Primary MCLs may not prevent**
“detrimental physiological responses...”
- n **MCLs derived for water distribution systems**
- n **Balancing health vs. technology/economics may not be relevant to drinking water sources or future beneficial use protection**
 - u **Total trihalomethane MCL and chloroform**
 - **Accept some cancer risk to remove pathogens**
 - u **MCLs for chlorinated solvent carcinogens**
 - **Outdated analytical quantitation limits**
 - u **Arsenic MCLs ignore cancer risk**

Sources of Numeric Thresholds

Used to Implement Narrative Objectives

Toxicity objective

no “detrimental physiological responses...”



n California Public Health Goals

OEHHA

n Federal MCL Goals

USEPA

u non-“zero” levels only

n California Notification (Action) Levels CDPH

n Integrated Risk Information System USEPA

u Reference doses for non-cancer effects

u Cancer risk estimates

n Cancer risk estimates

OEHHA, NAS 66

1-in-a-Million (10^{-6}) Cancer Risk Level

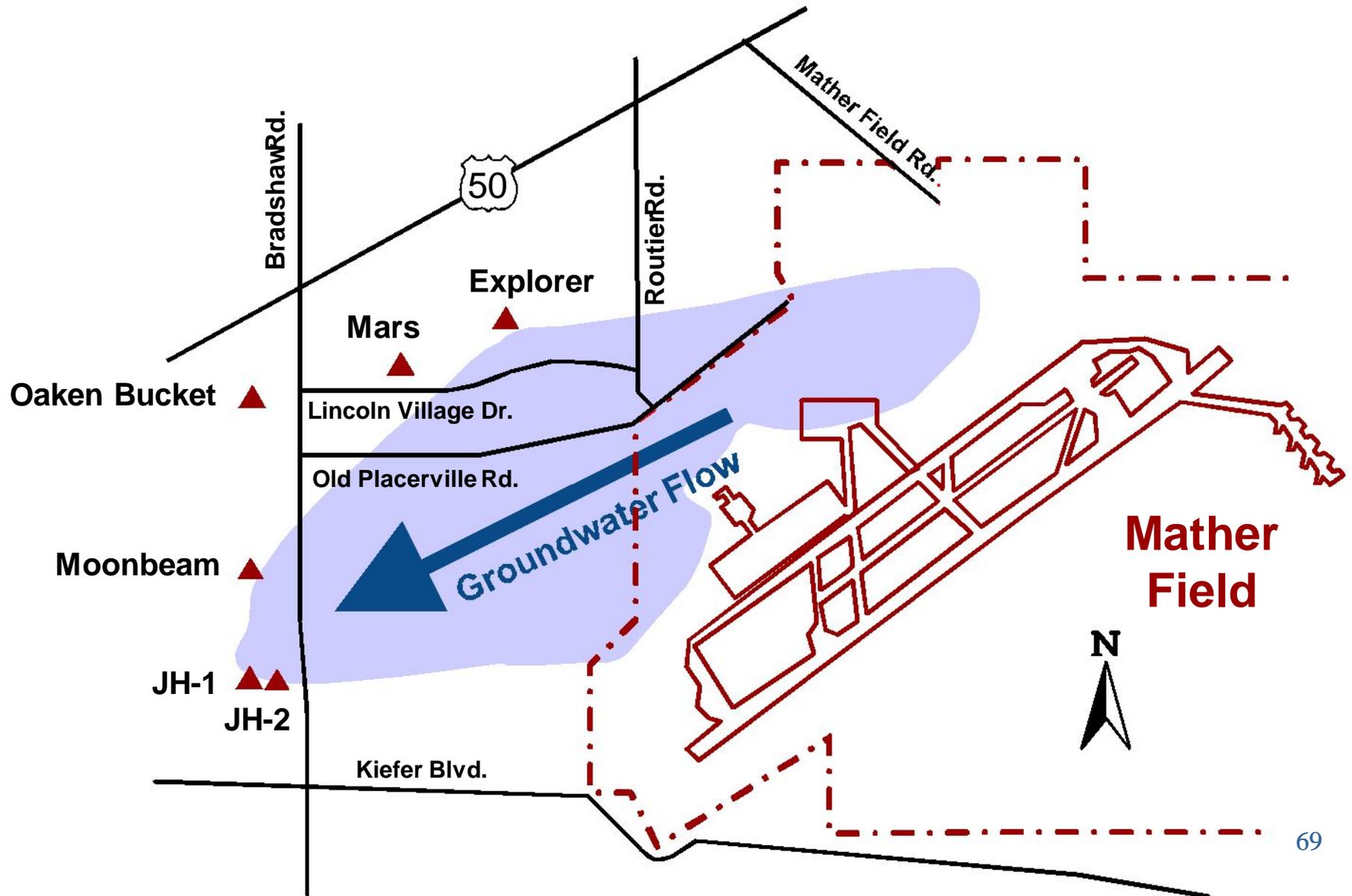
Used to Implement Narrative Toxicity Objective

- n **CDPH Primary MCLs and Notification Levels**
 - u *de minimis* cancer risk for involuntary exposure
- n **OEHHA Public Health Goals for drinking water**
 - u level considered negligible or *de minimis*
- n **California Toxics Rule and National Toxics Rule**
 - u human health criteria shall be applied at the State-adopted 10^{-6} risk level
- n **DTSC Prelim. Endangerment Assessments**
 - u $> 10^{-6}$ risk indicates presence of contamination which may pose significant threat to human health
- n **Example - Region 5 CAO for Mather AFB**

Mather AFB, Sacramento

- n **Solvents leaked into groundwater**
 - u **TCE, PCE, DCE & carbon tetrachloride**
 - u **Probable human carcinogens**
 - u **Plume extends off-base to west and north**
 - **Residential area**
- n **Several municipal wells impacted and threatened**

Mather AFB Groundwater Plume



Mather AFB, Sacramento

- n **Cleanup and Abatement Order**
 - u **Replace impacted water supply**
 - u **Contain solvent plume**
 - u **Cleanup groundwater pollution**
- n **Trigger = 10^{-6} cancer risk levels**
 - u **Lower than MCLs**

Sources of Numeric Thresholds

Used to Implement Narrative Objectives



Toxicity objective

n **Drinking Water
Health Advisories**

USEPA & NAS

n **Proposition 65 Regulatory Levels** **OEHHA**

- u **Carcinogens at 1-in-100,000 (10^{-5}) risk level**
- u **Reproductive toxins at 1/1000 of NOAEL**
- u **Intent of statute**

- **Public notice prior to exposure**
- **Prohibit discharge to drinking water sources**
- **Not establishment of levels considered “safe”**

Sources of Numeric Thresholds

Used to Implement Narrative Objectives

Toxicity objective



n **National Recommended
(Ambient) Water Quality Criteria**

USEPA

u **Human Health protection**

- **Assume ingestion of aquatic organisms**
- **Apply to surface waters only**

u **Aquatic Life protection**

n **Pesticide Hazard Assessments**

DFG

u **Aquatic Life Protective Thresholds**

for DPR

Aquatic Life Protective Thresholds



- n **USEPA National Recommended Water Quality Criteria & CTR / NTR Criteria**
 - u **Calculated from toxicity data**
 - **Species representing = 8 families of organisms**
 - **Both vertebrate and invertebrate species**
 - u **Chronic (4-day avg.) & acute (1-hour avg.)**
 - u **Protection of all species for which there are reliable measurements in the data set**
 - u **Intended to protect species for which those in the data set serve as surrogates**

Aquatic Life Protective Thresholds



- n USEPA National Recommended Water Quality Criteria & CTR / NTR Criteria**
 - u Freshwater criteria**
 - Where salinity < 1 part per thousand
 - u Saltwater criteria**
 - Where salinity > 10 parts per thousand
 - u Use more stringent of freshwater and saltwater criteria**
 - Where salinity between 1 and 10 parts per thousand

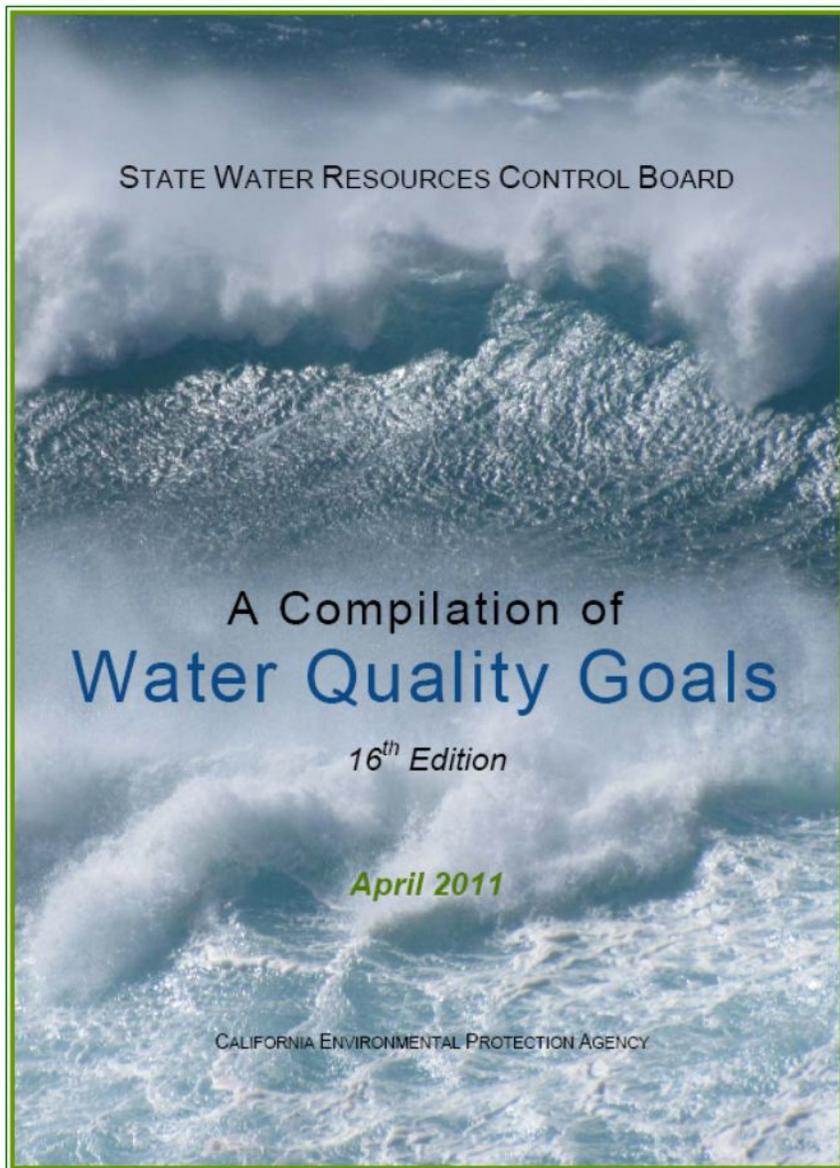
Sources of Numeric Thresholds

Used to Implement Narrative Objectives



Taste and Odor objective

- n Secondary MCLs CDPH & USEPA
- n National Recommended (Ambient) Water Quality Criteria USEPA
- n Drinking Water Health Advisories USEPA & NAS
- n Taste and Odor Thresholds USEPA & others



A Source of Numeric Thresholds

Available on
the Internet at

[www.waterboards.ca.gov/
water_issues/programs/
water_quality_goals/](http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/)

Sources of Numeric Thresholds

from Implementation Chapter of
Sacramento River and San Joaquin River Basin Plan

n Pesticide discharges from non-point sources

- u Most pesticides lack numeric water quality objectives, recommended criteria, or guidance
- u Board will consider $1/10$ of LC_{50} for most sensitive aquatic life species as upper limit to protect aquatic life
 - Based on valid toxicity data
 - Lower limits if needed (e.g., LOEC or NOEC)



Aquatic Life Toxicity Data

n **Ecotoxicology Database**

- u **On line at**
<http://cfpub.epa.gov/ecotox/>
- u **Single chemical toxicity information for aquatic and terrestrial life**
 - e.g., LC₅₀, LOEC, NOEC
- u **Consult original scientific paper to ensure an understanding of the context of the data**





Toxicology Basics

Do not be afraid!

Toxicology Basics

n Paracelsus (1493–1541)

- u All things are poison and nothing is without poison
- u Only the dose permits something not to be poisonous
- u *"The dose makes the poison."*



Toxicology Basics

- n All chemicals are toxic
- n Toxicity dependent on
 - u Potency of chemical
 - u Amount of exposure
 - Concentration x Duration = Dose
 - Units of mg/kg/day
- n Degree of effect depends on dose
 - u Dose-Response relationship



Two Dose-Response Relationships

n **Threshold
Toxins**



n **Non-threshold
Toxins**

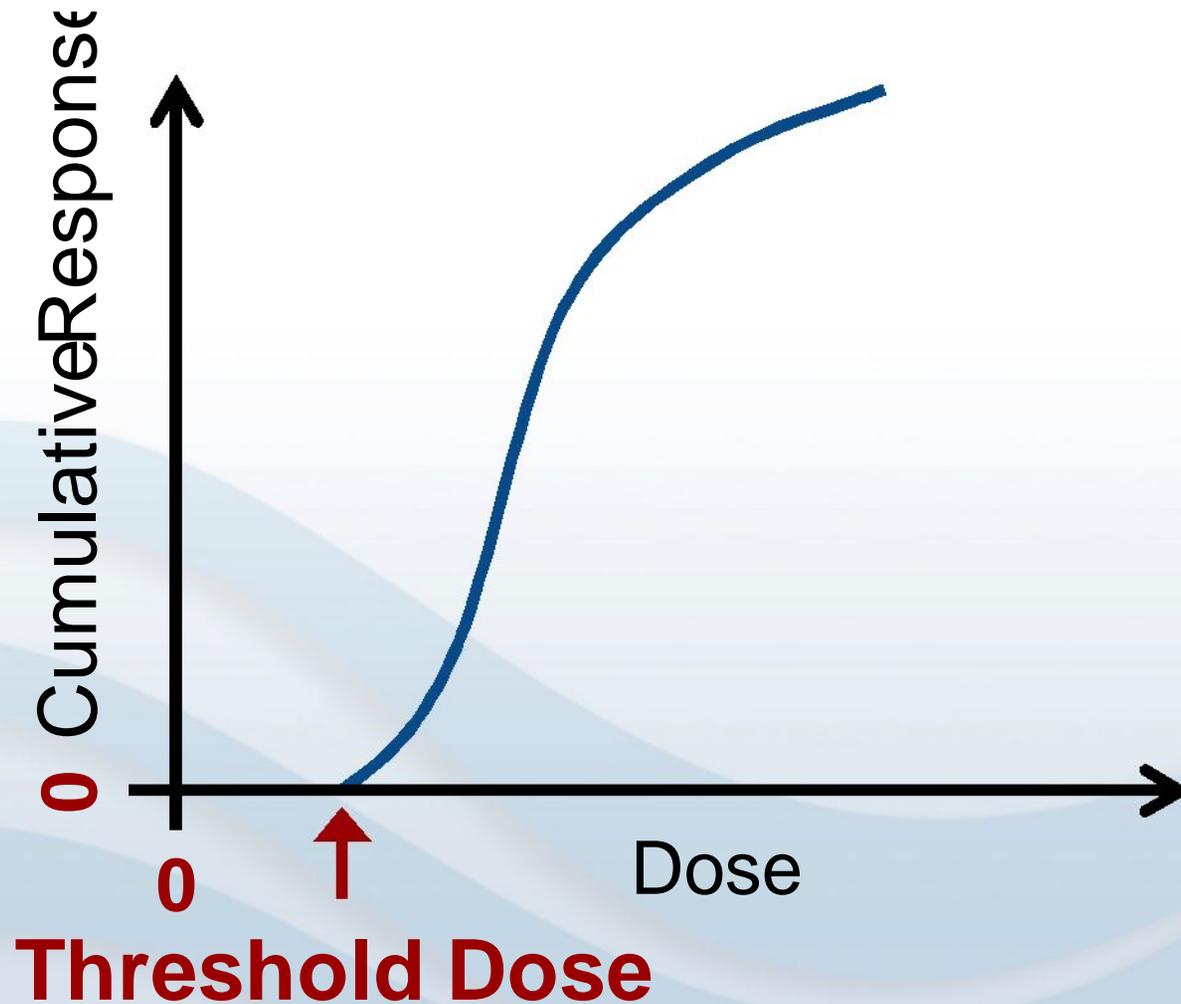


Threshold Toxins



- n **Below a particular dose, there is no toxic effect**
- n **Examples: cyanide, mercury, malathion**
- n **Some toxic chemicals are beneficial at low doses but toxic at higher doses**
 - u **e.g., Vitamin A**

Threshold Dose-Response Relationship

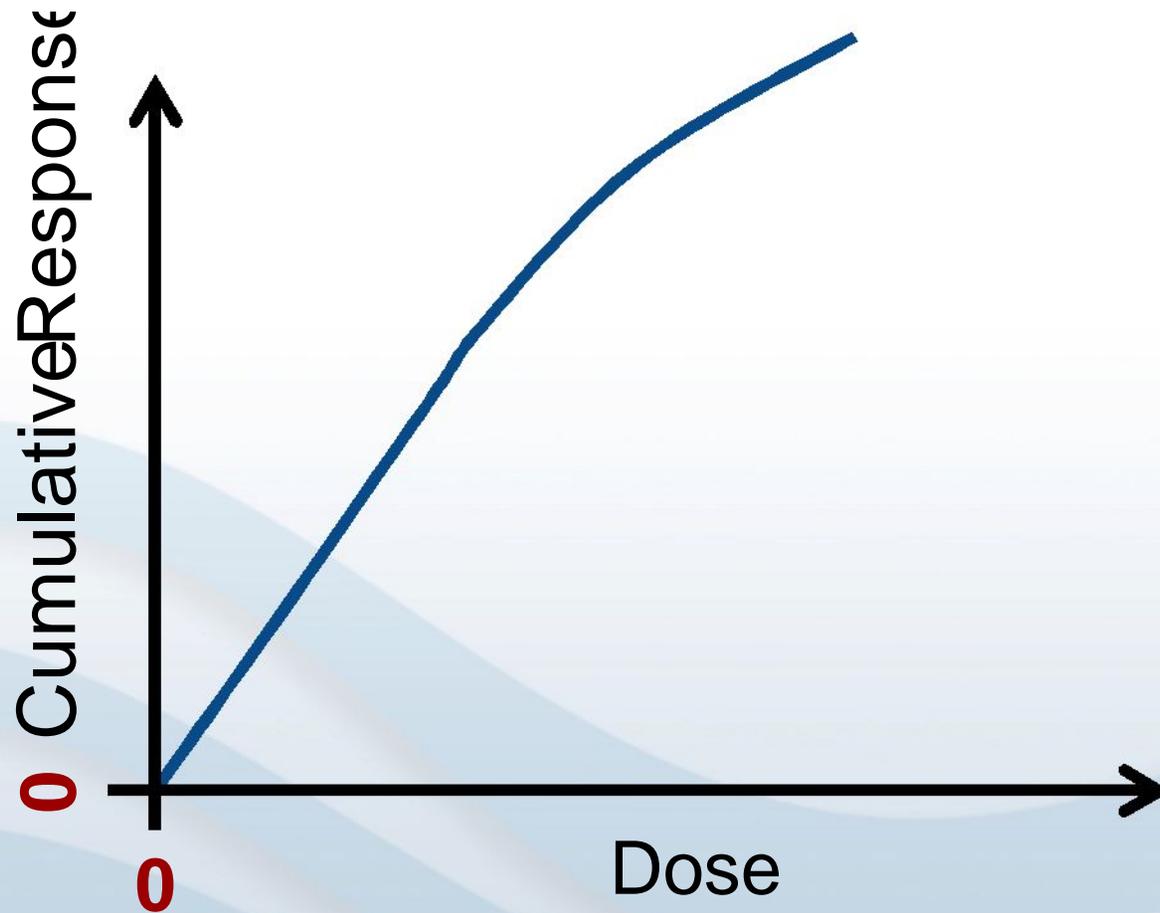


Non-threshold Toxins



- n **Some toxicity or health risk at any dose**
- n **Most carcinogens in this category**
- n **Cancer risk is a probabilistic event**
 - u **The higher the dose,
the higher the probability
of experiencing the toxic effect**
 - u **Risk proportional to dose or concentration**
 - **If 1-in-a million (10^{-6}) risk at 1 ug/L**
 - **Then 1-in-100,000 (10^{-5}) risk at 10 ug/L**

Non-threshold Dose-Response Relationship



USEPA Weight of Evidence Classes

1986 and 2005 Guidelines

Class A **Known human carcinogen**

Class H **Carcinogenic to humans**

- u **Sufficient evidence ties human exposure to cancer**
- u **Can not deliberately experiment on humans**
- u **Few chemicals – Arsenic, Benzene, Vinyl chloride, radioactive elements**



USEPA Weight of Evidence Classes

1986 and 2005 Guidelines

Class B Probable human carcinogen

Class L Likely to be carcinogenic
to humans

- u Limited human evidence
- u Sufficient animal evidence



USEPA Weight of Evidence Classes

2005 Guidelines

Class L/N Likely to be carcinogenic above a specified dose but not likely to be carcinogenic below that dose

- u Key event in tumor formation does not occur below that dose
 - e.g., tissue damage



USEPA Weight of Evidence Classes

1986 and 2005 Guidelines

Class C **Possible human carcinogen**

Class S **Suggestive evidence of
carcinogenic potential**

- u **No human evidence**
- u **Limited animal evidence**



USEPA Weight of Evidence Classes

1986 and 2005 Guidelines

Class D **Unknown**

Class I **Inadequate information
to assess
carcinogenic potential**

- u **Insufficient cancer risk data
to assign chemical
to another category**



USEPA Weight of Evidence Classes

1986 and 2005 Guidelines

Class E **Not a carcinogen**

Class N **Not likely to be
carcinogenic to humans**

- u **Sufficient evidence exists to indicate that chemical does not cause cancer**



Calculating Health-Based Numeric Thresholds



n Non-Threshold Toxins

- u Risk proportional to dose

- u Risk and dose related by
Cancer Potency (Slope) Factor (q_1^*)

- Risk per unit dose
- Units of $(\text{mg/kg/day})^{-1}$

Calculating Health-Based Numeric Thresholds



n Non-Threshold Toxins

1. Risk Level = Dose x Potency Factor

2. Dose = Concentration x 2 liters/day ÷ 70 kg
(mg/kg/day) (mg/L)

3. Concentration =
(mg/L)

Risk Level x 70 kg

Potency Factor x 2 liters/day

Calculating Health-Based Numeric Thresholds



n Threshold Toxins

u Dose Levels from toxicity studies

- No Observed Adverse Effect Level (**NOAEL**)

? Highest dose with no adverse effect

- Lowest Observed Adverse Effect Level (**LOAEL**)

? Lowest dose that caused measurable effect

u NOAEL or LOAEL used to calculate Reference Dose (**RfD**)

- Units of **mg/kg/day**

Calculating Health-Based Numeric Thresholds

n Threshold Toxins



4. Reference Dose =
(mg/kg/day)

NOAEL (or LOAEL)

Uncertainty Factor

RfD Uncertainty Factors

- n **3 to 10 for each of these that apply**
 - u **Extrapolating from animal studies to humans**
 - u **Using a LOAEL in place of a NOAEL**
 - u **Using a less appropriate route of exposure**
 - u **Using a study with subchronic exposure**
 - u **Potential synergism among chemicals**
 - u **Any other toxicologic data gaps**
- n **Multiply them together to derive overall uncertainty factor**



Calculating Health-Based Numeric Thresholds

n Threshold Toxins



4. Reference Dose =
(mg/kg/day)

NOAEL (or LOAEL)

Uncertainty Factor

Calculating Health-Based Numeric Thresholds



n Threshold Toxins (continued)

Drinking Water RfD x 70 kg
5. Equivalent Level =
DWEL (mg/L) 2 liters/day

Lifetime DWEL x 20% RSC
6. Health Advisory =
(mg/L) Additional Uncertainty Factor*

* 10 for Class C or S carcinogens

Relative Source Contribution (RSC)

- n **RSC = Proportion of exposure (dose) assumed to come from drinking water**
- n **(1 – RSC) = proportion of exposure from other sources**
 - u **Food we eat (other ingestion)**
 - u **Air we breathe (inhalation)**
 - u **Things we touch (dermal absorption)**
- n **Default RSC = 20%**
- n **Modify if reliable exposure data available**



Calculating Health-Based Numeric Thresholds



n Threshold Toxins (continued)

$$\begin{array}{l} \text{Drinking Water} \quad \text{RfD} \times 70 \text{ kg} \\ \text{5. Equivalent Level} = \\ \text{DWEL (mg/L)} \quad \text{2 liters/day} \end{array}$$

$$\begin{array}{l} \text{Lifetime} \quad \text{DWEL} \times 20\% \text{ RSC} \\ \text{6. Health Advisory} = \\ \text{(mg/L)} \quad \text{Additional Uncertainty Factor}^* \end{array}$$

* 10 for Class C or S carcinogens

Routes of Exposure



n Most Human Health-Based Thresholds

- u Assume water ingestion (2 liters/day)
 - USEPA IRIS, USEPA Health Advisories, Cal/EPA Cancer Factors, NAS Levels

n Public Health Goals for VOCs **OEHHA**

- u Assume overall human exposure resulting from water use in the home
 - Ingestion of water
 - Inhalation of chemical vapor
 - Dermal exposure from bathing

Routes of Exposure



- n USEPA National Recommended Water Quality Criteria & CTR/NTR Criteria**
 - u Human health protective thresholds assume two exposure scenarios based on bioaccumulation & bioconcentration**
 - Ingestion of water and aquatic organisms**
 - ? Applies to all surface waters designated MUN or per SWRCB Resolution 88-63**
 - Ingestion of aquatic organisms only**
 - ? Applies to non-MUN surface waters**

Let's Take a Break



Terminology Review

- n **Water Quality Standards**
- n **Beneficial Uses**
- n **Water Quality Criteria**
- n **Water Quality Objectives**
- n **Drinking Water Standards**
- n **Numeric Thresholds**
- n **Assessment Threshold**
- n **Water Quality Goals**



“Water Quality Standards”

- n **Federal Clean Water Act**
 - u **Navigable waters and their tributaries (surface water)**
- n **Aspects of State or Federal Law**
- n **Two parts**
 - u **Designated uses of water to be protected**
 - u **Water quality criteria to protect those uses**
- n **Antidegradation Policies**
 - u **Often considered part of W.Q. Standards**

“Beneficial Uses”



- n **Porter-Cologne Act** **California term** 
- n **Uses of water**
to be protected against degradation
- n **Found in Water Quality Control Plans**
- n **Groundwater and Surface Water**
- n **Discharge of Waste**
 - u **Not a beneficial use of water**
 - u **Cannot occur to the detriment of beneficial uses**

“Water Quality Criteria”



- n **Federal Clean Water Act (surface water)**
- n **Limits for constituents or characteristics of water to protect specific uses**
- n **Two types**
 - u **Clean Water Act Section 303(c) Criteria**
 - **Enforceable limits under CWA (promulgated)**
 - ? **California Toxics Rule & National Toxics Rule**
 - u **Clean Water Act Section 304(a) Criteria**
 - **Advisory to states and tribes**
 - ? **National Recommended Water Quality Criteria**

“Water Quality Objectives”



- n Porter-Cologne Act **California term** 
- n Limits for constituents or characteristics of water to protect **beneficial** uses
- n Found in Water Quality Control Plans
- n Groundwater and Surface Water
- n Same legal status as CWA Section 303(c) criteria

“Drinking Water Standards”

n Adopted by CDPH or USEPA

- u Pursuant to state and federal Safe Drinking Water Acts



n Enforceable on Water Purveyors

- u Applies to water in a drinking water distribution system and at the tap

n Becomes a Water Quality Objective

- u Only when incorporated by reference in a Water Quality Control Plan (Basin Plan)
- u Does not supersede other water quality objectives

“Numeric Thresholds”

- n **Not a legal term**
- n **As used in *Water Quality Goals*:**
 - u **Numeric criteria and guidelines from other agencies and organizations**
 - u **Intended to protect one or more specific uses of water**
 - u **Used to implement narrative water quality objectives**

“Assessment Threshold”

n Not a legal term

n As used in *Water Quality Goals*:

u Most stringent of the following

- Applicable numeric water quality objectives
- Applicable CTR and NTR criteria
- Numeric thresholds used to implement narrative water quality objectives

u Selected to comply with *all* applicable

- Narrative & numeric water quality objectives
- Promulgated water quality criteria (CTR/NTR)¹¹²

“Water Quality Goals”

- n **Reference tools to help you understand and implement water quality standards**
- n **Not a policy or a regulation**
- n **Two Parts**
 - u **Staff Report**
 - *A Compilation of Water Quality Goals*
 - u **Online searchable database**
 - **Additional tools**

Staff Report

“A Compilation of Water Quality Goals”

- n **Preface** (what's new)
 - n **How to Use Water Quality Goals Online**
 - n **Selecting Water Quality Goals**
 - u **Water Quality Standards**
 - u **Types of Numeric Thresholds**
 - u **Risk Characterization Methods** (toxicology)
 - u **Selecting Assessment Thresholds**
 - u **Assessment Threshold Algorithms**
- } this class

Water Quality Goals Online

n Database of numeric thresholds

u Search by

- Chemical name or portion of name
- Abbreviation
- Chemical Abstracts Service Registry Number

u Synonyms

u Description of each threshold type

u Footnotes (information and limitations)

u References (primary sources with hyperlinks)

u Adoption dates

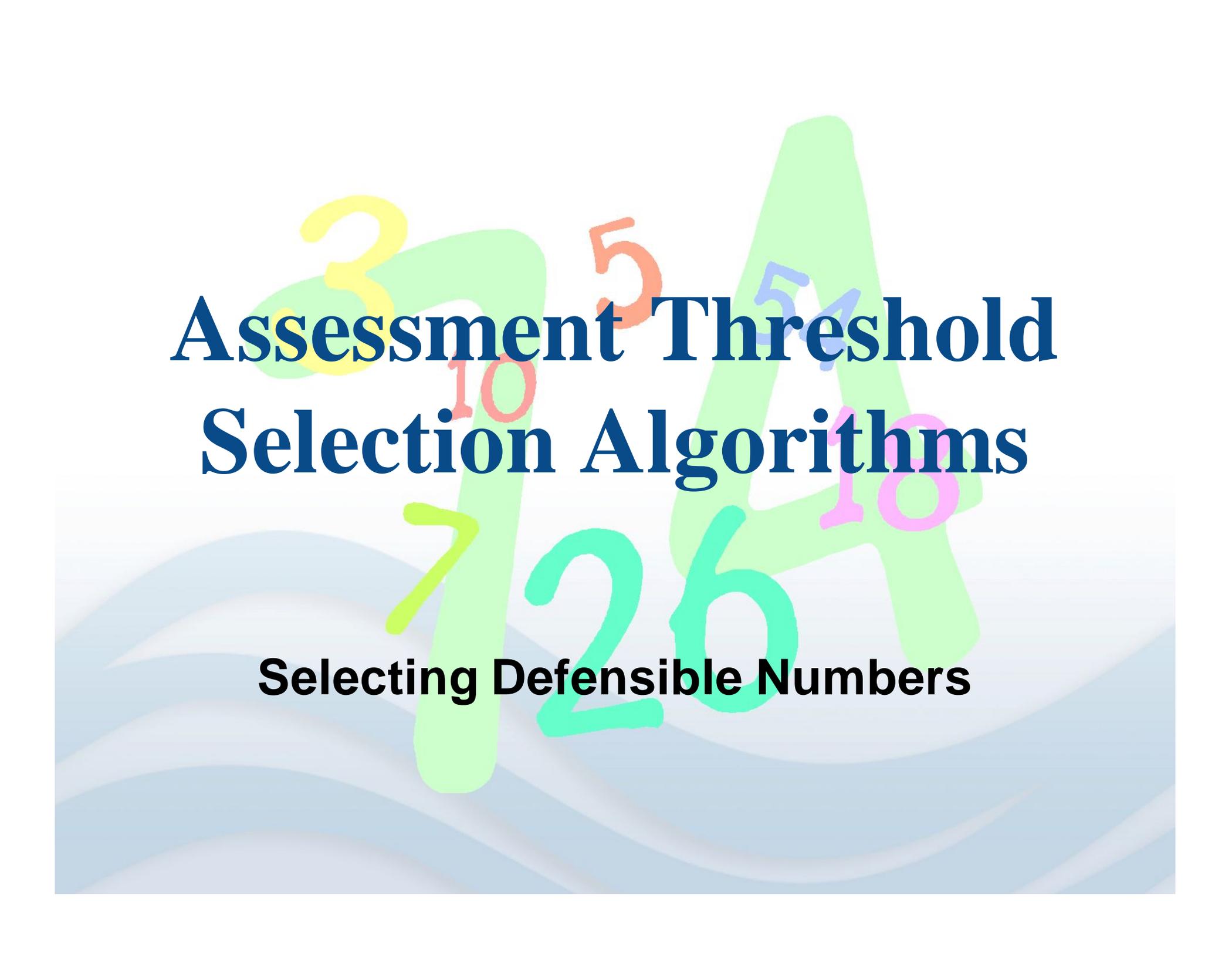
Water Quality Goals Online

- n Database updated regularly**
- n Additional tools**
 - u How to use online database**
 - u Staff Report**
 - u Assessment thresholds table**
 - u Download thresholds, footnotes, references**
 - Tab text format for database upload**
 - u Detailed list of updates**
 - u Sign up for email updates**

Water Quality Goals Online

Database Demonstration

[www.waterboards.ca.gov/water_issues/
programs/water_quality_goals/](http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/)



Assessment Threshold Selection Algorithms

Selecting Defensible Numbers

Assessment Threshold Selection

- n To be defensible, **numeric thresholds** should be chosen to implement each applicable water quality objective and promulgated water quality criterion
- n **Assessment threshold** is the most limiting of the above

Algorithms – Main Steps

- Step 1.** Select a single **numeric threshold** to satisfy each applicable water quality objective and promulgated criterion or relevant portion thereof
- Step 2.** To satisfy all applicable objectives select the lowest threshold from Step 1 as the **assessment threshold**
- Step 3.** Adjust for natural background levels
- u Uncontrollable factors

Selecting Numeric Thresholds

- n **Lowest number you can find may not be appropriate**
- n **Promulgated thresholds**
- n **Defensibility**
 - u **Avoid arbitrary selection**
 - u **Carefully document selection**
 - u **Cite original references**
 - **Not “Water Quality Goals”**
- n **Case-specific information**



Algorithms – Guiding Principles for Step 1

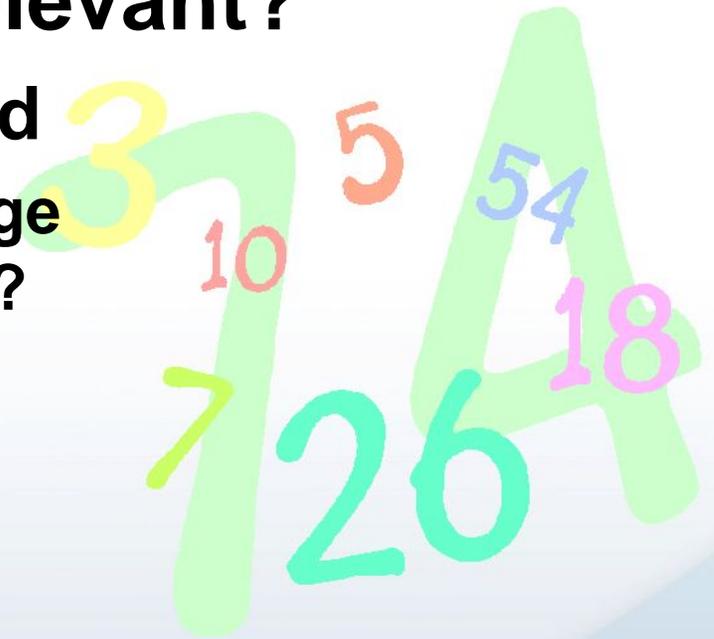
n Is numeric threshold relevant?

u Check intent of threshold

- Does it match the language of the narrative objective?

u Check exposure routes

- Are they suitable for the beneficial use being protected?



Algorithms – Guiding Principles for Step 1

- n Use risk-based numeric thresholds instead of risk management-based thresholds to implement narrative water quality objectives**
 - u Toxicity-based thresholds instead of MCLs**
 - u Risk management-based thresholds may contain irrelevant information or constraints**
 - e.g., outdated analytical quantitation limits or constraints imposed by another agency's regulatory scheme**

Algorithms – Guiding Principles for Step 1

- n **Use California numeric thresholds when available**
 - u **Instead of federal numeric thresholds or thresholds from other sources**
 - u **Consistency within Cal/EPA and with other California agencies**



Algorithms – Guiding Principles for Step 1

- n Use numeric thresholds that reflect peer-reviewed science**
 - u Avoid using draft or provisional thresholds unless nothing else is available**
- n Use numeric thresholds that reflect current science**
 - u Check dates**

Assessment Threshold Algorithms

Water Body Types

- n **Water Quality Goals, 13th Edition (2003)**
 - u **Groundwater**
 - u **Inland Surface Waters**
- n **Water Quality Goals, 16th Edition (2011)**
 - Added
 - u **Enclosed Bays & Estuaries**
 - u **Ocean Waters**

Assessment Threshold Algorithms

Limiting Beneficial Uses

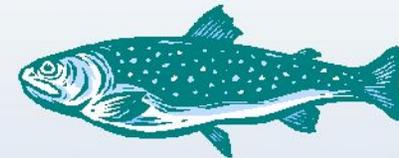
n Groundwater

- u Municipal and domestic supply
- u Agricultural supply



n Inland Surface Waters

- u Municipal and domestic supply
- u Agricultural supply
- u Aquatic life protection
- u Fish and shellfish consumption

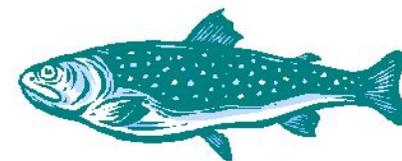


Assessment Threshold Algorithms

Limiting Beneficial Uses

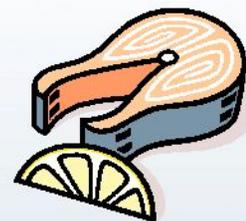
n Enclosed Bays & Estuaries

- u Aquatic life protection
- u Fish and shellfish consumption
- u **No water consumption or agricultural use**



n Ocean Waters

- u Aquatic life protection
- u Fish and shellfish consumption
- u **No water consumption or agricultural use**



Assessment Threshold Algorithms

Aquatic Life Protection

- n **Inland Surface Waters Algorithm**
 - u Where salinity < 10 parts per thousand
- n **Enclosed Bays & Estuaries Algorithm**
 - u Non-ocean waters
 - u Where salinity > 1 part per thousand



Algorithm for Groundwater

✓ **Chemical Constituents Objective**

∅ **Numeric W. Q. Objective from Basin Plan**

∅ **Drinking Water MCLs – *select lowest of:***

§ **California Primary MCL**

§ **California Secondary MCL**

∅ **Threshold indicating beneficial use impairment – *select lowest of:***

§ **Agricultural use threshold**

§ **Federal Primary MCL if < CA Primary MCL**

Algorithm for Groundwater



✓ Toxicity Objective

- ∅ Drinking water health-based – *select first of:*
 - § OEHHA Public Health Goal
 - § Cal/EPA Cancer Potency Factor (at 10^{-6})
 - § CDPH Notification Level
 - § USEPA IRIS – *lowest of cancer or reference dose*
 - § USEPA Health Advisory – *lowest*
 - § USEPA MCL Goal – *non-“zero”*
 - § Other – *check basis and dates*
 - National Academy of Sciences – cancer or SNARL
 - Prop 65 safe harbor levels

Algorithm for Groundwater



✓ **Tastes and Odors Objective**

∅ **Taste- and odor-based thresholds –**
select first of:

§ **California Secondary MCL**

– *if not altered by cost or technology*

§ **Federal Secondary MCL**

– *if not altered by cost or technology*

§ **USEPA National Rec. Water Quality Criterion**

– *if based on taste or odor **of water***

§ **Other taste and odor thresholds**

– *in peer-reviewed published literature*

Algorithm for Groundwater

Step 1. Select a number for each \emptyset item

u Use table in Figure 3 on page 30

Water Quality Objective / Criterion	Relevant Portion of Objective / Criterion	Source	Concentration	Units
Chemical Constituents	Drinking Water MCL (lowest)	CDPH		
	Numerical Water Quality Objective	Basin Plan		
	Beneficial Use Impairment Numeric Threshold			
Toxicity	Human Health – Drinking Water			
Tastes & Odors	Taste & Odor Based Numeric Thresholds for Water			

Step 2. Select lowest number from Step 1 as the assessment threshold

u To satisfy all applicable objectives

Step 3. Adjust for natural background

u uncontrollable factors

Algorithm for Inland Surface Waters

n Different from groundwater algorithm

u Additional beneficial uses

- Aquatic life protection
- Fish and shellfish consumption



u Promulgated water quality criteria

- California Toxics Rule & National Toxics Rule
- Limit application of narrative toxicity objective to protect
 - ? Human health
 - ? Aquatic life

Algorithm for Inland Surface Waters

✓ **California and National Toxics Rules**

∅ **Criteria for human health protection**

§ **Water and fish consumption for MUN waters**

§ **Fish consumption only for non-MUN waters**

∅ **Criteria for aquatic life protection**

§ **Criteria Continuous Concentration (4-day avg.)**

§ **Criteria Maximum Concentration (1-hour avg.)**

Algorithm for Inland Surface Waters

✓ **Chemical Constituents Objective**

∅ **Numeric W.Q. Objective from Basin Plan**

- May supersede CTR and NTR criteria if approved by USEPA

∅ **Drinking Water MCLs**

- Same as in groundwater algorithm

∅ **Threshold indicating beneficial use impairment**

- Same as in groundwater algorithm

Algorithm for Inland Surface Waters



✓ Toxicity Objective

∅ Drinking water health-based thresholds

Apply if no CTR or NTR human health criteria

— Same as in groundwater algorithm

∅ Human health, including fish consumption

§ USEPA National Recomm. Water Quality Criteria

Apply if no CTR or NTR human health criteria

• Water and fish consumption for MUN

• Fish consumption only for non-MUN

Algorithm for Inland Surface Waters

✓ **Toxicity Objective (continued)**



∅ **Aquatic life protective thresholds –
*select first:***

Apply if no CTR or NTR aquatic life criteria

§ **California Department of Fish and Game Criteria**

§ **USEPA National Recomm. Water Quality Criteria**

- **Criteria Continuous Concentration
(4-day avg.)**
- **Criteria Maximum Concentration
(1-hour avg.)**
- **Other averaging periods**

Algorithm for Inland Surface Waters

✓ **Tastes and Odors Objective**

∅ Taste- and odor-based thresholds

- Same as in groundwater algorithm **except**
USEPA National Recomm. Water Qual. Criterion
based on taste or odor of water or fish flesh



Algorithm for Inland Surface Waters

Step 1. Select a number for each \emptyset item

- u Use table in Figure 4 on page 33

Step 2. Select lowest number from Step 1 as the assessment threshold

- u To satisfy all applicable objectives

Step 3. Adjust for natural background

- u uncontrollable factors

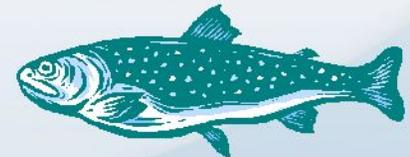
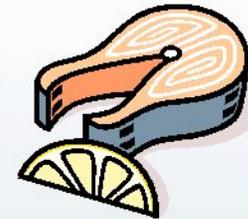
Algorithm for Inland Surface Waters

n Table in Figure 4 on page 33

Water Quality Objective / Criterion	Relevant Portion of Objective / Criterion	Source	Concentration	Units
California Toxics Rule / National Toxics Rule	Human Health Protection	CTR or NTR		
	Aquatic Life Protection – CCC	CTR or NTR		
	Aquatic Life Protection – CMC	CTR or NTR		
Chemical Constituents	Drinking Water MCL (lowest)	CDPH		
	Numerical Water Quality Objective	Basin Plan		
	Beneficial Use Impairment Numeric Threshold			
Toxicity	Human Health – Drinking Water			
	Human Health – Fish Consumption	USEPA, NRWQC		
	Aquatic Life Protection – CCC			
	Aquatic Life Protection – CMC			
Tastes & Odors	Taste & Odor Based Numeric Thresholds			

Algorithm for Enclosed Bays & Estuaries

- n **Similar to inland surface waters algorithm**
 - u **CTR and NTR criteria may trump toxicity narratives**
- n **Different from inland surface waters algorithm**
 - u **No MUN use**
 - u **Human health criteria limited to fish and shellfish consumption**
 - u **No AGR use**
 - u **Aquatic life criteria – check salinity**
- n **Use table in Figure 5 on page 35**



Algorithm for Enclosed Bays & Estuaries

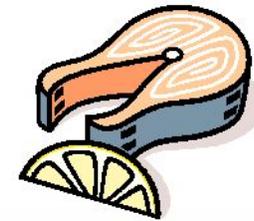
n Table in Figure 5 on page 35

Water Quality Objective / Criterion	Relevant Portion of Objective / Criterion	Source	Concentration	Units
California Toxics Rule / National Toxics Rule	Human Health Protection	CTR or NTR		
	Aquatic Life Protection – CCC	CTR or NTR		
	Aquatic Life Protection – CMC	CTR or NTR		
Chemical Constituents	Numerical Water Quality Objective	Basin Plan		
Toxicity	Human Health – Fish Consumption	USEPA, NRWQC		
	Aquatic Life Protection – CCC			
	Aquatic Life Protection – CMC			

Algorithm for Ocean Waters

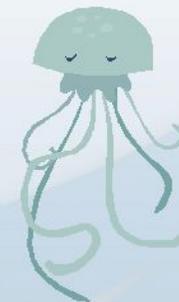
n Similar to enclosed bays & estuaries algorithm

- u Human health criteria limited to fish and shellfish consumption



n Different from enclosed bays & estuaries algorithm

- u CTR and NTR criteria do not apply
- u California Ocean Plan objectives
 - Trump narrative toxicity objectives
- u Aquatic life criteria – saltwater



n Use table in Figure 6 on page 36

Algorithm for Ocean Waters

n **Table in Figure 6 on page 36**

Water Quality Objective / Criterion	Relevant Portion of Objective / Criterion	Source	Concentration	Units
California Ocean Plan	Human Health Protection	Ocean Plan		
	Marine Aquatic Life Protection – 6-month median	Ocean Plan		
	Marine Aquatic Life Protection – daily maximum	Ocean Plan		
	Marine Aquatic Life Protection – instantaneous maximum	Ocean Plan		
Chemical Constituents	Numerical Water Quality Objective	Basin Plan		
Toxicity	Human Health – Fish Consumption	USEPA, NRWQC		
	Aquatic Life Protection – CCC			
	Aquatic Life Protection – CMC			

Assessment Thresholds Table

- n On Water Quality Goals web page
- n For commonly encountered constituents and parameters
- n Algorithm tables filled in for you
- n For all water body types
 - u G = groundwater
 - u IS = inland surface waters
 - u E = enclosed bays and estuaries
 - u O = ocean waters
- n To protect limiting beneficial uses

Let's Take a Break



Selecting Assessment Thresholds

a groundwater example

Leaking waste oil tank site

Zinc, TCE, Benzene, and Xylene
found in groundwater samples



- n **Goal: “Has pollution occurred?”**
- n **Check the Basin Plan**
 - u What are the beneficial uses?
 - u What water quality objectives apply?
- n **Select numeric threshold for each objective**
- n **Which of these thresholds is most restrictive?**
 - u Compare with measured concentrations

Selecting Assessment Thresholds

a groundwater example

Leaking waste oil tank site

Zinc, TCE, Benzene, and Xylene
found in groundwater samples



- n **Goal: “Has pollution occurred?”**
- n **Check the Basin Plan**
 - u What are the beneficial uses?
 - u What water quality objectives apply?
- n **Select numeric threshold for each objective**
- n **Which of these thresholds is most restrictive?**
 - u Compare with measured concentrations

Selecting Assessment Thresholds

a groundwater example

Chemical Constituents Objective

∅ Numeric water quality objectives see Basin Plan

∅ California MCLs

§ Primary

TCE 5 ug/L

Benzene 1 ug/L

Xylene 1,750 ug/L

§ Secondary

Zinc 5,000 ug/L

(draft)

Xylene 20 ug/L

∅ Beneficial use protection

§ Agricultural use

Zinc 2,000 ug/L

§ Federal MCLs if lower

(none are lower)

Selecting Assessment Thresholds

a groundwater example

Chemical Constituents Objective

∅ Numeric water quality objectives see Basin Plan

∅ California MCLs

§ Primary

TCE

5 ug/L

Benzene

1 ug/L

Xylene

1,750 ug/L

Zinc

5,000 ug/L

§ Secondary

(draft)

Xylene

20 ug/L

∅ Beneficial use protection

§ Agricultural use

Zinc

2,000 ug/L

§ Federal MCLs if lower

(none are lower)

Selecting Assessment Thresholds

a groundwater example

Toxicity Objective – Zinc

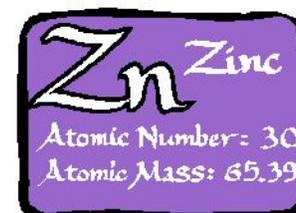
∅ Human Health – Drinking Water

§ USEPA IRIS – Reference Dose

2,100 ug/L

§ USEPA Health Advisory

2,000 ug/L



Selecting Assessment Thresholds

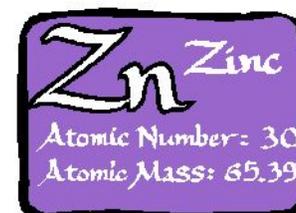
a groundwater example

Toxicity Objective – Zinc

∅ Human Health – Drinking Water

§ USEPA IRIS – Reference Dose

§ USEPA Health Advisory

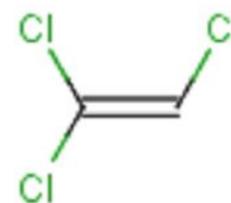


2,100 ug/L

2,000 ug/L

Selecting Assessment Thresholds

a groundwater example

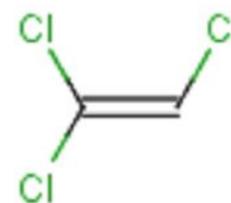


Toxicity Objective – TCE

∅	Human Health – Drinking Water	
§	OEHHA Public Health Goal	1.7 ug/L
§	Cal/EPA Cancer Potency Factor	5.9 ug/L
§	USEPA IRIS	
§	Reference Dose (draft)	2.8 ug/L
§	Cancer risk estimate (draft)	0.7 ug/L
§	USEPA Health Advisory – cancer	3 ug/L
§	USEPA MCL Goal	zero
§	Other	
•	NAS cancer risk level	1.5 ug/L
•	Prop 65 NSRL	25 ug/L

Selecting Assessment Thresholds

a groundwater example

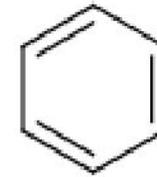


Toxicity Objective – TCE

∅ Human Health – Drinking Water

§ OEHHA Public Health Goal	1.7 ug/L
§ Cal/EPA Cancer Potency Factor	5.9 ug/L
§ USEPA IRIS	
§ Reference Dose (draft)	2.8 ug/L
§ Cancer risk estimate (draft)	0.7 ug/L
§ USEPA Health Advisory – cancer	3 ug/L
§ USEPA MCL Goal	zero
§ Other	
• NAS cancer risk level	1.5 ug/L
• Prop 65 NSRL	25 ug/L

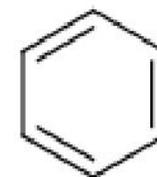
Toxicity Objective – Benzene



∅ Human Health – Drinking Water

§	OEHHA Public Health Goal	0.15	ug/L
§	Cal/EPA Cancer Potency Factor	0.35	ug/L
§	USEPA IRIS		
	• Reference Dose	28	ug/L
	• Cancer Risk Estimate (range)	1 to 10	ug/L
§	USEPA Health Advisory		
	• Non-cancer effects (10-day)	200	ug/L
	• Cancer risk estimate	1	ug/L
§	USEPA MCL Goal	zero	
§	Other		
	• Prop 65 – cancer	3.2	ug/L
	• Prop 65 – reproductive toxicity	12	ug/L

Toxicity Objective – Benzene



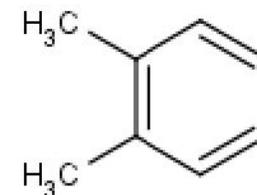
∅ Human Health – Drinking Water

§ OEHHA Public Health Goal	0.15 ug/L
§ Cal/EPA Cancer Potency Factor	0.35 ug/L
§ USEPA IRIS	
• Reference Dose	28 ug/L
• Cancer Risk Estimate (range)	1 to 10 ug/L
§ USEPA Health Advisory	
• Non-cancer effects (10-day)	200 ug/L
• Cancer risk estimate	1 ug/L
§ USEPA MCL Goal	zero
§ Other	
• Prop 65 – cancer	3.2 ug/L
• Prop 65 – reproductive toxicity	12 ug/L

Selecting Assessment Thresholds

a groundwater example

Toxicity Objective – Xylene



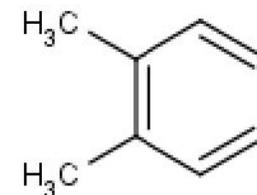
∅ Human Health – Drinking Water

§ California Primary MCL	(1,750 ug/L)
§ OEHHA Public Health Goal	1,800 ug/L
§ USEPA IRIS – Reference Dose	1,400 ug/L
§ USEPA Health Advisory	1,400 ug/L
§ USEPA MCL Goal	10,000 ug/L

Selecting Assessment Thresholds

a groundwater example

Toxicity Objective – Xylene



∅ Human Health – Drinking Water

§ California Primary MCL	(1,750 ug/L)
§ OEHHA Public Health Goal	1,800 ug/L
§ USEPA IRIS – Reference Dose	1,400 ug/L
§ USEPA Health Advisory	1,400 ug/L
§ USEPA MCL Goal	10,000 ug/L

Selecting Assessment Thresholds

a groundwater example



Toxicity Objective – Summary

∅ Zinc	USEPA IRIS Reference Dose	2,100	ug/L
∅ TCE	California Public Health Goal	1.7	ug/L
∅ Benzene	California Public Health Goal	0.15	ug/L
∅ Xylene	California Public Health Goal	1,800	ug/L
	California Primary MCL	(1,750	ug/L)

Selecting Assessment Thresholds

a groundwater example



Taste and Odor Objective

∅ Taste & odor based thresholds

§ California 2C MCLs	Zinc	5,000 ug/L
§ Federal 2C MCLs	Zinc	5,000 ug/L
(draft)	Xylene	20 ug/L
§ USEPA NRWQC - T&O	Zinc	5,000 ug/L
§ Other T&O thresholds		
• 1989 Federal Register & USEPA Fact Sheets	Xylene	17 ug/L
• Peer reviewed journal	Benzene	170 ug/L
	TCE	310 ug/L

Selecting Assessment Thresholds

a groundwater example



Taste and Odor Objective

∅ Taste & odor based thresholds

§ California 2C MCLs

Zinc 5,000 ug/L

§ Federal 2C MCLs
(draft)

Zinc 5,000 ug/L

Xylene 20 ug/L

§ USEPA NAWQC - T&O

Zinc 5,000 ug/L

§ Other T&O thresholds

- 1989 Federal Register & USEPA Fact Sheets
- Peer reviewed journal

Xylene 17 ug/L

Benzene 170 ug/L

TCE 310 ug/L

Selecting Assessment Thresholds

a groundwater example

Numeric Thresholds – Zinc



<i>Water Quality Objective</i>	<i>Threshold</i>	
∅ Chemical Constituents (Numeric)	see Basin Plan	
∅ Chemical Constituents (MCL)	5,000	ug/L
∅ Chemical Constituents (Ben. Use)	2,000	ug/L
∅ Toxicity	2,100	ug/L
∅ Taste & Odor	5,000	ug/L

Selecting Assessment Thresholds

a groundwater example

Assessment Threshold – Zinc

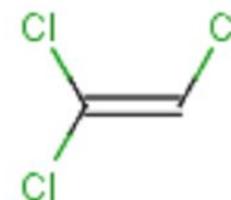


<i>Water Quality Objective</i>	<i>Threshold</i>	
<input checked="" type="checkbox"/> Chemical Constituents (Numeric)	see Basin Plan	
<input type="checkbox"/> Chemical Constituents (MCL)	5,000	ug/L
<input checked="" type="checkbox"/> Chemical Constituents (Ben. Use)	2,000	ug/L
<input type="checkbox"/> Toxicity	2,100	ug/L
<input type="checkbox"/> Taste & Odor	5,000	ug/L

Selecting Assessment Thresholds

a groundwater example

Numeric Thresholds – TCE

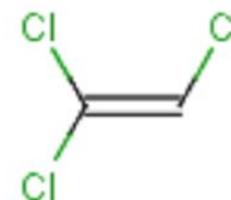


<i>Water Quality Objective</i>	<i>Threshold</i>
∅ Chemical Constituents (Numeric)	see Basin Plan
∅ Chemical Constituents (MCL)	5 ug/L
∅ Chemical Constituents (Ben. Use)	–
∅ Toxicity	1.7 ug/L
∅ Taste & Odor	310 ug/L

Selecting Assessment Thresholds

a groundwater example

Assessment Threshold – TCE

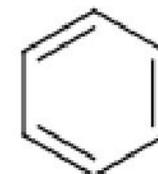


<i>Water Quality Objective</i>	<i>Threshold</i>
<input checked="" type="checkbox"/> Chemical Constituents (Numeric)	see Basin Plan
<input type="checkbox"/> Chemical Constituents (MCL)	5 ug/L
<input type="checkbox"/> Chemical Constituents (Ben. Use)	–
<input checked="" type="checkbox"/> Toxicity	1.7 ug/L
<input type="checkbox"/> Taste & Odor	310 ug/L

Selecting Assessment Thresholds

a groundwater example

Numeric Thresholds – Benzene

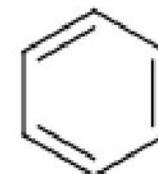


<i>Water Quality Objective</i>	<i>Threshold</i>
∅ Chemical Constituents (Numeric)	see Basin Plan
∅ Chemical Constituents (MCL)	1 ug/L
∅ Chemical Constituents (Ben. Use)	–
∅ Toxicity	0.15 ug/L
∅ Taste & Odor	170 ug/L

Selecting Assessment Thresholds

a groundwater example

Assessment Threshold – Benzene

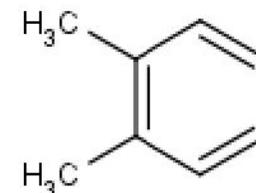


<i>Water Quality Objective</i>	<i>Threshold</i>
<input checked="" type="checkbox"/> Chemical Constituents (Numeric)	see Basin Plan
<input type="checkbox"/> Chemical Constituents (MCL)	1 ug/L
<input type="checkbox"/> Chemical Constituents (Ben. Use)	–
<input checked="" type="checkbox"/> Toxicity	0.15 ug/L
<input type="checkbox"/> Taste & Odor	170 ug/L

Selecting Assessment Thresholds

a groundwater example

Numeric Thresholds – Xylene

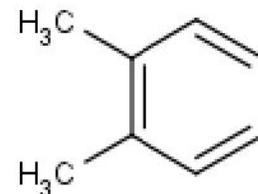


<i>Water Quality Objective</i>	<i>Threshold</i>	
∅ Chemical Constituents (Numeric)	see Basin Plan	
∅ Chemical Constituents (MCL)	1,750	ug/L
∅ Chemical Constituents (Ben. Use)		
∅ Toxicity	1,800	ug/L
∅ Taste & Odor	17	ug/L

Selecting Assessment Thresholds

a groundwater example

Assessment Threshold – Xylene



<i>Water Quality Objective</i>	<i>Threshold</i>
<input checked="" type="checkbox"/> Chemical Constituents (Numeric)	see Basin Plan
<input type="checkbox"/> Chemical Constituents (MCL)	1,750 ug/L
<input type="checkbox"/> Chemical Constituents (Ben. Use)	
<input type="checkbox"/> Toxicity	1,800 ug/L
<input checked="" type="checkbox"/> Taste & Odor	17 ug/L

Selecting Assessment Thresholds

a groundwater example

Assessment thresholds to implement all applicable water quality objectives

n	Zinc	Agricultural Use Limit	2,000	ug/L
n	TCE	California Public Health Goal	1.7	ug/L
n	Benzene	California Public Health Goal	0.15	ug/L
n	Xylene	Taste & Odor Threshold	17	ug/L

(Unless numeric water quality objectives are lower)

Analytical Quantitation Limits

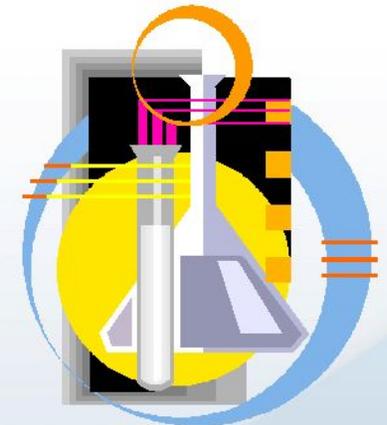
- n **If assessment < quantitation threshold limit**

May need different analytical method

- Available Methods? • Cost?

- n **Check method quantitation limits**

- Should lab be able to do better?
- u **Minimum Levels in SIP**
- u **Minimum Levels in Ocean Plan**
- u **Detection Limits for Purposes of Reporting (DLRs) from CDPH**
- u **Analytical method manuals – NEMI**





Additive Toxicity Criterion for Multiple Constituents

From *Policy for Application of Water Quality Objectives*
in the Implementation Chapter of the Central Valley Region Basin Plans

Similar language in Water Board regulations

23 CCR, Chapter 15 2550.4 and 27 CCR 20400(g)



- n **Multiple toxic pollutants together in water**
 - u **Potential for toxicologic interactions**
- n **Generally assume additive toxicity for**
 - u **Pollutants that are carcinogens**
 - u **Pollutants that manifest their toxic effects on the same organ systems or through similar mechanisms**

Additive Toxicity Criterion for Multiple Constituents

$$\sum_{i=1}^n \frac{[\text{Concentration of Constituent}]_i}{[\text{Toxicologic Threshold in Water}]_i} < 1.0$$

Additive Toxicity Criterion for Multiple Constituents

$$\sum_{i=1}^n \frac{[\text{Concentration of Constituent}]_i}{[\text{Toxicologic Threshold in Water}]_i} < 1.0$$

	Found	10⁻⁶ Cancer Risk Estimate
Benzene	0.1 ug/L	0.15 ug/L
TCE	1.5 ug/L	1.7 ug/L

Additive Toxicity Criterion for Multiple Constituents

$$\sum_{i=1}^n \frac{[\text{Concentration of Constituent}]_i}{[\text{Toxicologic Threshold in Water}]_i} < 1.0$$

	Found		10^{-6} Cancer Risk Estimate
Benzene	0.1 ug/L		0.15 ug/L
TCE	1.5 ug/L		1.7 ug/L
	0.1	+	1.5
	0.15		1.7
		=	1.5

Additive Toxicity Criterion for Multiple Constituents

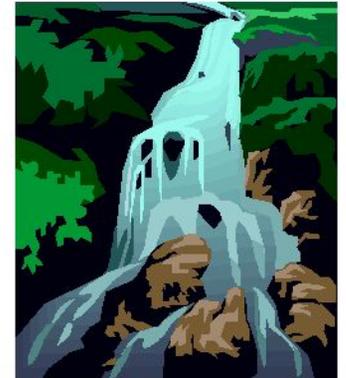
$$\sum_{i=1}^n \frac{[\text{Concentration of Constituent}]_i}{[\text{Toxicologic Threshold in Water}]_i} < 1.0$$

	Found	10^{-6} Cancer Risk Estimate
Benzene	0.1 ug/L	0.15 ug/L
TCE	1.5 ug/L	1.7 ug/L

$$\begin{array}{r}
 0.1 \\
 0.15
 \end{array}
 +
 \begin{array}{r}
 1.5 \\
 1.7
 \end{array}
 =
 \text{1.5 violation}$$

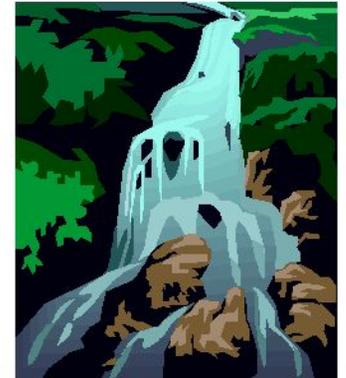
A Case for Antidegradation

- n **The same water is used many times**
 - u **Each use causes some degradation**
- n **Many human activities also cause water quality degradation**
- n **If one use or activity is permitted to degrade water quality to just below the water quality objective, no room exists for degradation from other uses or activities that will occur**
 - u **Beneficial uses are likely to be impaired by the next use or activity**



A Case for Antidegradation

- n **Our understanding of health and environmental effects of chemicals is constantly evolving**
 - u **What we believe to be safe at 10 ppb today may be found to be harmful at 1 ppb tomorrow**
 - u **Our knowledge of effects of chemical combinations is very limited**
- n **Desirable to minimize the degree of water quality degradation**



State Water Board Resolution No. 68-16 (1968)

**Statement of Policy with Respect to Maintaining
High Quality of Waters in California**

California's "Antidegradation Policy"

**"Whenever the existing quality of
water is better than the quality
established in policies, . . .**

such existing high quality will be maintained

. . . "



State Water Board Resolution No. 68-16 (1968)

**Statement of Policy with Respect to Maintaining
High Quality of Waters in California**

California's "Antidegradation Policy"

**" . . . until it has been demonstrated
to the State that any change**



- u will be consistent with maximum benefit to the people of the State,**
- u will not unreasonably affect present and anticipated beneficial use of such water and**
- u will not result in water quality less than that prescribed in the policies."**

State Water Board Resolution No. 68-16 (1968)

**Statement of Policy with Respect to Maintaining
High Quality of Waters in California**

California's "Antidegradation Policy"

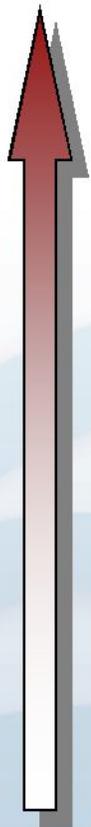
“Any activity which produces or may produce a waste . . . and which discharges or proposes to discharge to existing high quality waters will be required to meet waste discharge requirements which will result in the **best practicable treatment or control of the discharge necessary to assure that**

- u pollution or nuisance will not occur and**
- u the highest water quality consistent with maximum benefit to the people of the State will be maintained.”**



Appropriate Range of Water Quality to Protect Beneficial Uses

Increasing Concentrations



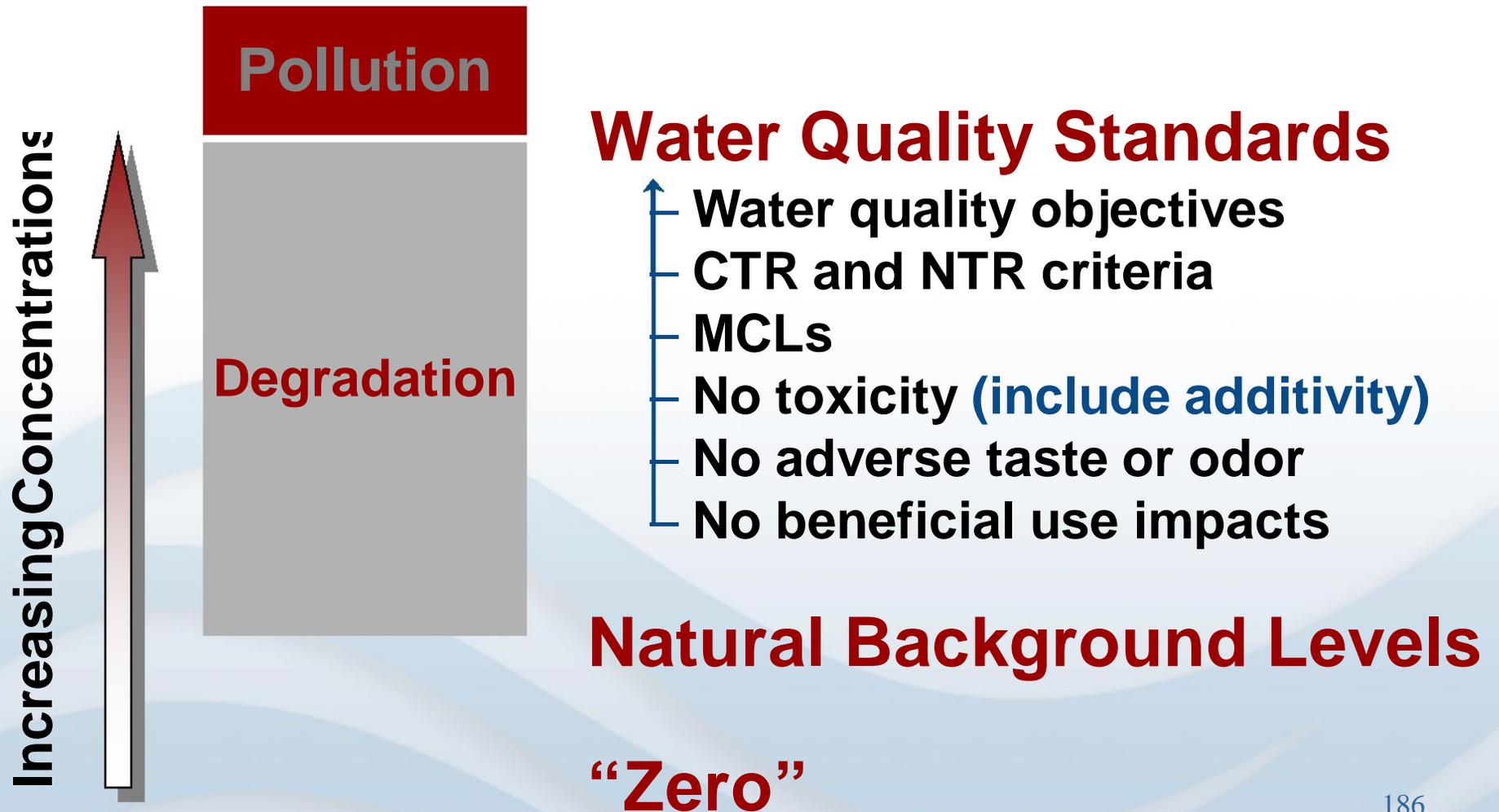
Water Quality Standards

- Water quality objectives
- CTR and NTR criteria
- MCLs
- No toxicity (include additivity)
- No adverse taste or odor
- No beneficial use impacts

Natural Background Levels

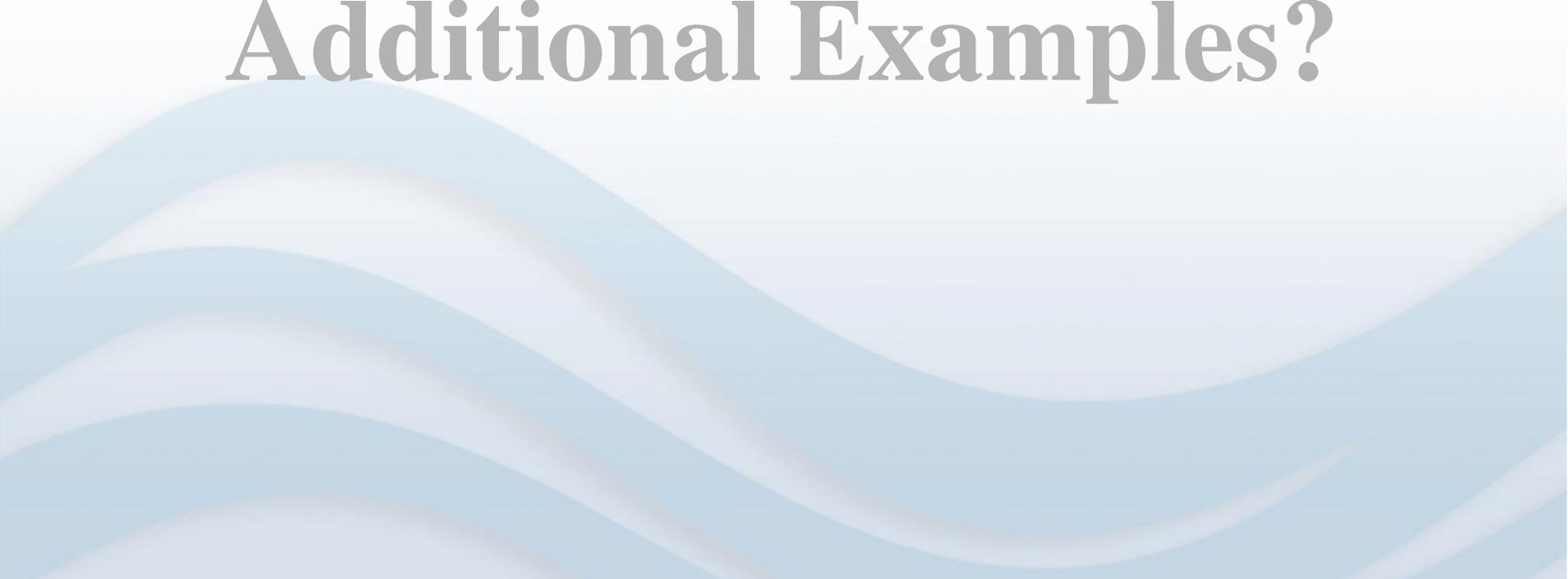
“Zero”

Degradation and Pollution



Questions?

Additional Examples?



**Please fill out your
Evaluation Form.**

Thank you.





CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS