United States
Environmental Protection
Agency

Office of Science and Technology
Standards and Applied Science Division
(4305)

EPA 823-B-97-004
March 1997

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WATER QUALITY
STANDARDS
ACADEMY

Basic Course
PARTICIPANT MANUAL
1997 Edition

Office of Water
Office of Science and Technology

United States Environmental Protection Agency
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Basic Course

PARTICIPANT MANUAL

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Office of Water
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This manual provides a basic overview of EPA's water quality standards program. These materials are for instructional purposes only. Water quality standards program requirements and acceptable options for meeting those requirements are expressed in the Agency's regulations, policy, and guidance referenced and outlined herein.

PREFACE

This "Water Quality Standards Training Academy" provides structured training on the objectives of the water quality standards and criteria programs, the interpretation and application of the Water Quality Standards Regulation policies and program guidance, and the relationship of water quality standards to other programs. This is a basic introductory course.

This is a 5-day course that consists of 23 individual training modules. The course is comprised of a variety of instructional activities, including lectures, case studies, class exercises, problem-solving activities, role-play, and discussions. Certificates will be awarded upon successful completion.

Two sets of manuals are used in this course: the *Participant Manual* and the *Basic Course Reference Manual*. This is the *Participant Manual*. Each module contains a summary page that provides information on the objectives of the module, the format used to teach the module, the length of the module, and references. References are identified as either Basic Course Reference Documents or Other Documents. The *Basic Course Reference Manual* that accompanies this manual contains copies of the Clean Water Act, the Water Quality Standards Regulation, reports, guidance, and other materials that supplement the information provided in the modules. The other documents listed for each module contain additional references that you may wish to refer to in order to receive further information about a particular subject.

After the summary page, you will find an outline of the information to be presented in the module. Following the outline, transcripts of videotapes and copies of handouts are provided. Review questions are located at the end of most modules.

WATER QUALITY STANDARDS ACADEMY
PARTICIPANT MANUAL
TABLE OF CONTENTS

page

PREFACE iii
AGENDA iv

Training Module 1
INTRODUCTIONS AND PARTICIPANT EXPECTATIONS
Summary Page 1-1
Outline 1-3
Handouts
1-1: Course Instructors 1-7

Training Module 2
OVERVIEW OF EPA, THE CLEAN WATER ACT, AND THE WATER QUALITY STANDARDS PROGRAM
Summary Page 2-1
Outline 2-3
Handouts
2-1: EPA Organization Chart 2-19
2-2: Office of Water Organization Chart 2-21
2-3: OST Organization Chart 2-23
2-4: History 2-25
2-5: CWA Provisions 2-27
2-6: Schematic 2-29
2-7: Federal Definition 2-31
2-8: WQS Example 2-33
2-9: Transcript 2-43
Review Questions 2-47

page

Training Module 3
DESIGNATED USES
Summary Page 3-1
Outline 3-3
Handouts
3-1: State A — Use Classification 3-13
3-2: State B — Use Classification 3-15
3-3: State C — Use Classification 3-17
3-4: State D — Use Classification 3-19
3-5: State E — Use Classification 3-23
3-6: Points to Consider 3-25
3-7: Removal 3-27
Review Questions 3-29

Training Module 4
CONDUCTING USE ATTAINABILITY ANALYSES
Summary Page 4-1
Outline 4-3
Handouts
4-1: Physical 4-11
4-2: Chemical 4-13
4-3: Steps in a Use Attainability Analysis 4-15
4-4: Steps in a Use Attainability Analysis (simplified version) 4-17
4-5: Summary Sheet 4-19
4-6: Case Study 4-21
Review Questions 4-29

Training Module 5
PRINCIPLES OF TOXICOLOGY
Summary Page 5-1
Outline 5-3
Handouts
5-1: IRIS Record *(to be distributed)* 5-25
Review Questions 5-43

page

Training Module 6
PRINCIPLES OF RISK ASSESSMENT
Summary Page .6-1
Outline .6-3
Handouts
6-1: Cadmium Toxicity Data 6-19
6-2: Selection of Critical Endpoint and Data Set 6-21
6-3: Determination of the Dose Corresponding to the NOAEL 6-23
6-4: Calculation of the RfD 6-25
6-5: Lifetime Cancer Risk 6-27
6-6: Cadmium Exposure Exercise 6-29
Review Questions 6-31

Training Module 7
INTRODUCTION TO CRITERIA DEVELOPMENT
Summary Page .7-1
Outline .7-3
Handouts
7-1: "Priority" Pollutants 7-11
7-2: Transcript 7-13

Training Module 8
HUMAN HEALTH CRITERIA
Summary .8-1
Outline .8-3
Handouts
8-1: Cadmium 8-11
8-2: FM Table 8-15
8-3: IRIS Record 8-17
8-4: Carcinogenic Chemical Calculation 8-33
8-5: Uncertainty Factors 8-35
8-6: Non-Carcinogenic Chemical Calculation 8-37
8-7: Pollutant List 8-39
Review Questions 8-61

page

Training Module 9
AQUATIC LIFE CRITERIA
Summary 9-1
Outline 9-5
Handouts
9-1: Statement 9-21
9-2: "Priority" Pollutants 9-23
9-3: No Criteria 9-27
9-4: Proposed Criteria 9-31
9-5: "Non-Priority" Pollutants 9-33
9-6: Recommended State Actions 9-37
9-7: Flow Chart 9-39
9-8: Freshwater 9-41
9-9: Sample Calculation 9-43
9-10: Site-Specific Criteria Flow Chart 9-47
9-11: Class Exercise 9-49
9-12: Video Transcript 9-53
Review Questions 9-63

Training Module 10
SEDIMENT CRITERIA
Summary Page 10-1
Outline 10-5
Handouts
10-1: Program Applications 10-17
10-2: Class Exercise 10-21
10-3: Instructions for Class Exercise 10-23
10-4: Classification Methods 10-25
Review Questions 10-27

page

Training Module 11
BIOLOGICAL CRITERIA
Summary Page 11-1
Outline 11-3
Handouts
11-1: Maine 11-31
11-2: Arkansas Narrative Criteria Example 11-33
11-3: Numeric Criteria for Ohio 11-35
11-4: Model of the Process 11-37
11-5: Field Data Sheet 11-39
11-6: Index of Biotic Integrity 11-43
11-7: Regional IBI Matrix 11-45
11-8: IBI Scoring Criteria 11-47
11-9: IBI Worksheet 11-49
11-10: Transcript 11-51
Review Questions 11-57

Training Module 12
PRINCIPLES OF ECOLOGICAL RISK ASSESSMENT
Summary Page 12-1
Outline 12-3
Handouts
12-1: Ecological Risk Assessment Framework 12-23
12-2: Ecological Risk Assessment Case Study 12-25
12-3: Dan River Watershed Conceptual Model 12-33
12-4: Hill's Criteria 12-35
12-5: 5 Case Study Brochures *(to be distributed)* 12-37
Review Questions 12-39

Training Module 13
PRINCIPLES OF RISK COMMUNICATION
Summary Page 13-1
Outline 13-3
Handouts
13-1: Seven Cardinal Principles of Risk Communication *(to be distributed)* 13-21
13-2: Group Exercise *(to be distributed)* 13-23
13-3: Instructions *(to be distributed)* 13-27
13-4: Improving Dialoque with Communities *(to be distributed)* 13-31

page

Training Module 14
ANTIDEGRADATION POLICY REQUIREMENTS
Summary Page 14-1
Outline 14-3
Handouts
14-1: Transcript 14-9
Review Questions 14-15

Training Module 15
VARIANCES
Summary Page 15-1
Outline 15-3
Review Questions 15-9

Training Module 16
ECONOMIC CONSIDERATIONS
Summary 16-1
Outline 16-3
Handouts
16-1: Transcript 16-19
16-2: Case Study Scenario 16-23
16-3: Case Study Summary 16-25
16-4: Case Study Worksheet 16-27
16-5: Municipal Affordability Screener for Mesa City *(to be distributed)* 16-31
16-6: Secondary Affordability Test (Financial Management Indicators for Mesa City) *(to be distributed)* 16-33
16-7: Socioeconomic Information 16-35
Review Questions 16-39

Training Module 17
MIXING ZONES
Summary Page 17-1
Outline 17-3
Handouts
17-1: Case Study 17-13
17-2: Case Study Questions 17-17
Review Questions 17-19

page

Training Module 18
THE WATER QUALITY STANDARDS SUBMITTAL AND APPROVAL PROCESS
Summary Page . . . 18-1
Outline . . . 18-3
Handouts
18-1: Certification . . . 18-17
18-2: Federal Rulemaking . . . 18-19
Review Questions . . . 18-25

Training Module 19
THE ENDANGERED SPECIES ACT AND THE WATER QUALITY STANDARDS PROGRAM
Summary Page . . . 19-1
Outline . . . 19-3
Handouts
19-1: Key Terms . . . 19-13
19-2: Flow Chart . . . 19-21
19-3: Summary of ESA Section 7 Consultations . . . 19-23
19-4: ESA Summary . . . 19-25
Review Questions . . . 19-29

Training Module 20
IMPLEMENTATION OF WQS
Summary Page . . . 20-1
Outline . . . 20-3
Handouts
20-1: Transcript . . . 20-23
20-2: TMDL Calculations . . . 20-31
20-3: Three Types of Pollutants . . . 20-35
20-4: NPDES . . . 20-37
20-5: Levels of Technology . . . 20-39
20-6: FOIA . . . 20-41
20-7: Information List . . . 20-43
Review Questions . . . 20-45

page

Training Module 21
WATER QUALITY STANDARDS ON INDIAN RESERVATIONS
Summary Page 21-1
Outline 21-3
Handouts
21-1: Transcript 21-13
Review Questions 21-17

Training Module 22
WQS TERMINOLOGY
Summary Page 22-1
Outline 22-3

Training Module 23
WRAP-UP/FEED BACK
Summary Page 23-1
Outline 23-3

TRAINING MODULE 5:
PRINCIPLES OF TOXICOLOGY

MODULE SUMMARY:

This module introduces basic principles and concepts of toxicology, including methods used to assess chemical toxicity, with a focus on human health and aquatic life toxicity.

> **NOTE:** *This module contains technical information regarding the scientific underpinnings of environmental toxicology. Participants are not expected to master this information upon completion of this module. Follow-up training and technical support will be required for most participants who will be directly involved in the development of water quality criteria. This module serves only as an introductory training session on principles of toxicology. Follow-up technical advisory support is available through EPA.*

OVERALL OBJECTIVES:

To provide an understanding of the principles of toxicology, including techniques used to assess toxicity, and how these principles relate to an understanding of the water quality standards and criteria programs.

MEASURABLE OBJECTIVES:

After completing this module, participants should be able to:

- List toxicologic endpoints of concern for humans and aquatic life
- Distinguish between acute and chronic toxicity, immediate and delayed toxicity, threshold and nonthreshold effects, and reversible and irreversible effects
- Explain how relationships between response and dose or concentration are used to quantify toxic effects
- Describe how data are evaluated in environmental toxicology
- List the pharmacokinetic processes that a toxicant undergoes in an organism
- Explain how chemical properties of the toxicant, conditions of exposure, and biological characteristics of the host can influence toxicity
- Describe the advantages and disadvantages of various tests used to assess toxicity

LOGISTICS:

Teaching Method: Lecture (with slides).

Approximate Presentation Time: 1¾ hours (Lecture—95 minutes; Review Questions—10 minutes).

Other Documents:

General

Amdur, M., et al. (1991) Casarett and Doull's Toxicology: The Basic Science of Poisons, 4th Edition.

Barnes, D.G., and M. Dourson. (1988) Reg. Toxicol. Pharmacol. 8:471-486. (Discussion of Reference Dose methodology.)

Public Health Service. (1990) Draft Toxicological Profile for Cadmium. U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry (ATSDR).

U.S. EPA. (1986) Ecological Risk Assessment. U.S. Environmental Protection Agency, Office of Pesticide Programs. (EPA/540/9-85-001).

Loomis, T.A. (1978) Essentials of Toxicology, 3rd Edition.

U.S. EPA. (1987) The Risk Assessment Guidelines of 1986. U.S. Environmental Protection Agency, Office of Health and Environmental Assessment. (EPA/600/8-87/045).

Aquatic

Coekerham, L.G., and B.S. Shane (eds). (1994) Basic Environmental Toxicology. CRC Press, Boca Raton, FL.

Eislee, R. (1985) Cadmium hazards to fish, wildlife, and invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service. Biol. Rep. 85(1.2).

Rand, G.M., (ed.). (1994). Fundamentals of Aquatic Toxicology II: Effects, Environmental Fate and Risk Assessment. Taylor & Francis, Bristol, PA.

U.S. EPA. (1984). Ambient Water Quality Criteria for Cadmium. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. (EPA 440/S-84-032).

MODULE 5 - OUTLINE
PRINCIPLES OF TOXICOLOGY

— INTRODUCTION —

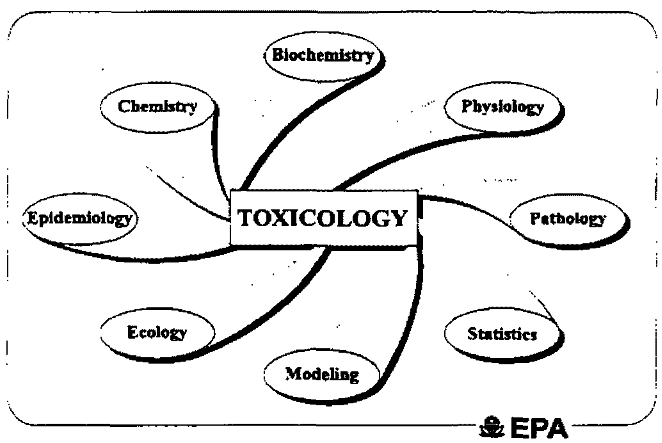
The objective of the Clean Water Act is to restore and maintain the chemical, physical, and biological integrity of the nation's water.

Water quality standards consist of three components:

- designated uses;
- criteria; and
- antidegradation policy.

Toxicology is the study of poisons (toxicants) and their effect on living biological systems.

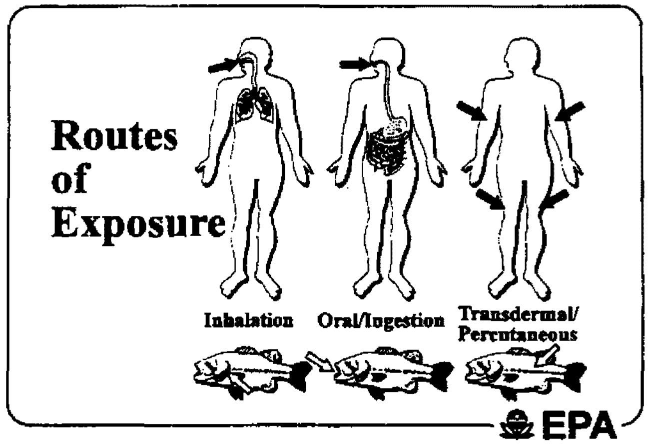
Slide 1: Toxicology



Environmental toxicology is the branch of toxicology that studies the effects resulting from the exposure of humans and other living organisms to chemicals in the environment.

Inhalation, ingestion, and passage through the skin are routes of exposure to toxicants in the environment.

Slide 2: Routes of Exposure



Chemicals may cause adverse effects in organisms because they interact with the body's vital functions. These interactions depend on the properties of the chemical compound and the amount of chemical present.

Endpoints are adverse effects that can be studied in the laboratory or in the environment.

Slide 3: Toxicologic Endpoints

TOXICOLOGIC ENDPOINTS

- **Lethality**
- **Carcinogenicity**
- **Mutagenicity**
- **Neurotoxicity**
- **Immunotoxicity**
- **Reproductive/Developmental Toxicity**
- **Target Organ Toxicity**
- **Ecological Effects**

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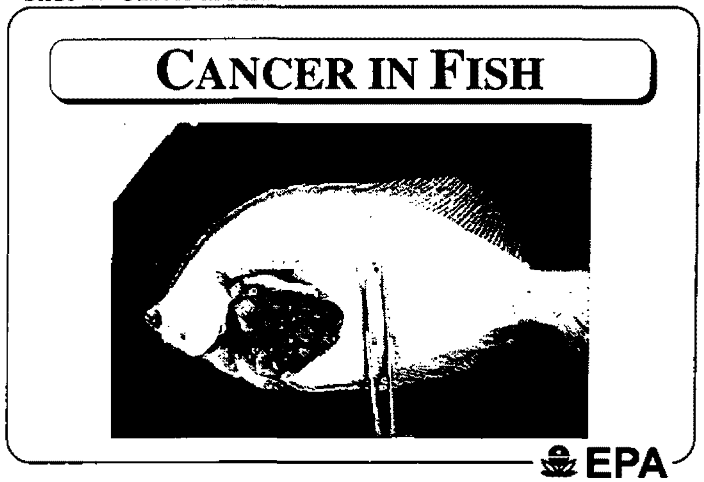
Lethality is the ability of a toxicant to cause the death of exposed individuals or populations.

Carcinogenicity is the ability of a toxicant to cause cancer.

Slide 4: Cancer in Fish



Mutagenicity is the ability of a toxicant to cause changes in the genetic material of cells.

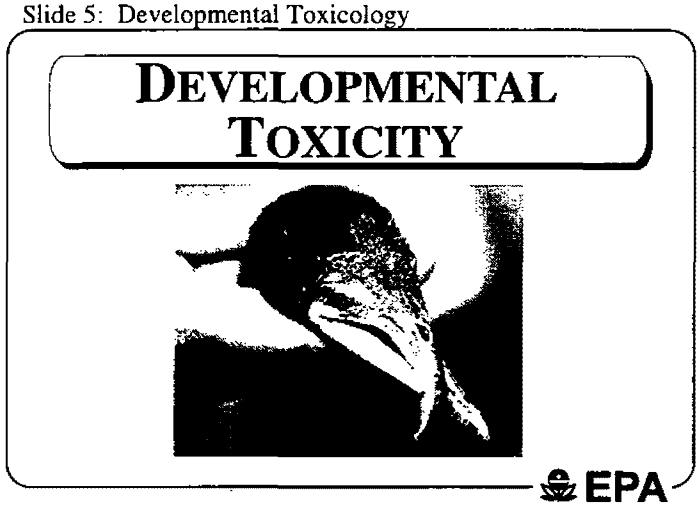
Neurotoxicity refers to adverse effects of a chemical on the structure or function of the nervous system.

Immunotoxicity refers to adverse effects of a toxicant on the function of the immune system.

Reproductive toxicity refers to adverse effects on an adult's reproductive capability.

Developmental toxicity refers to adverse effects on a growing organism.

Slide 5: Developmental Toxicology



Target organ toxicity refers to adverse effects of a toxicant on a particular organ or tissue.

Ecological effects refer to adverse effects of a toxicant on populations or communities of species in a natural ecosystem.

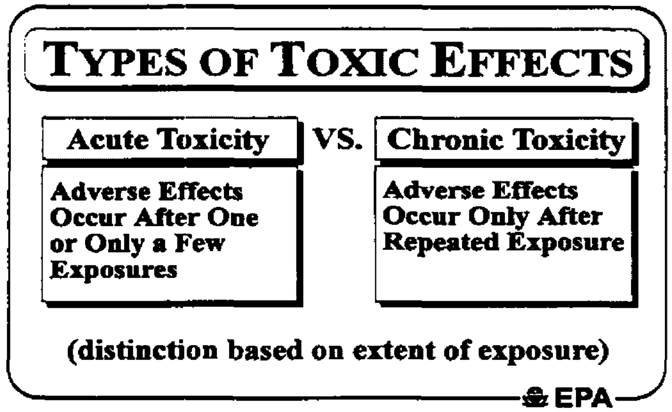
Ecological effects refer to adverse effects of a toxicant on populations or communities of species in a natural ecosystem.

— TERMS USED TO DESCRIBE TOXICOLOGICAL EFFECTS —

Acute toxicity describes adverse effects that occur after one or only a few exposures to a chemical over a short period of time.

Chronic toxicity refers to adverse effects that appear only after repeated or continuous exposure to a chemical, usually over an extended period of time.

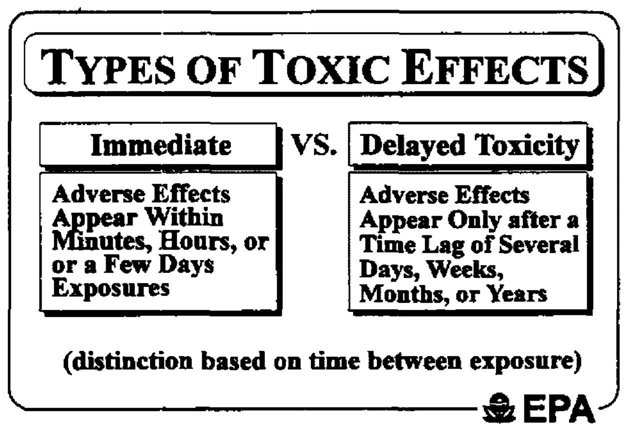
Slide 6: Acute vs. Chronic



Immediate toxicity refers to adverse effects that occur right away.

Delayed toxicity refers to effects that appear only after a time lag.

Slide 7: Immediate vs. Delayed



If there is some dose level below which a chemical generally does not cause an adverse effect. the effect is said to have a threshold.

Effects that occur even at infinitesimally small exposures to a chemical are referred to as nonthreshold effects.

Slide 8: Threshold vs. Nonthreshold

TYPES OF TOXIC EFFECTS

Threshold Effects	VS.	Nonthreshold
Adverse Effects Do Not Occur Below Some Specified Dose or Concentration		Adverse Effects Can Occur as a Result of Exposure to Even a Single Molecule of the Toxicant

(distinction based on the presence or absence of effects at very low doses)

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Adverse effects that last only as long as a person is exposed to the chemical are called reversible effects.

Adverse effects that persist or intensify even after exposure to the chemical has ended are called irreversible effects.

Slide 9: Reversible vs. Irreversible

TYPES OF TOXIC EFFECTS

Reversible	VS.	Irreversible Effects
Adverse Effects Disappear When Exposure to the Chemical Ends		Adverse Effects Persist Even After Exposure to a Chemical Ends

(distinction based on permanence of effects)

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Cadmium is a useful example for illustrating toxicological properties.

Slide 10: Cadmium Toxicity

CADMIUM TOXICITY

Organism	Exposure	Effect
Human	Inhalation 24 hour, high dose	Irritation of upper airway membranes, chest pains, nausea, dizziness
Human Wistar Rat	Inhalation, Low to moderate dose months to years	Kidney damage Lung cancer
Quail	Ingestion, Moderate dose, weeks	Anemia, bone marrow & heart damage

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Slide 11: Cadmium Toxicity

CADMIUM TOXICITY

Organism	Exposure	Effect
Fish	Inhalation/Ingestion Percutaneous High dose, hours to days	Gill damage
Fish	Inhalation/Ingestion/ Percutaneous Low dose months to years	Intestine, kidney damage
Water Flea	Inhalation/Ingestion/ Percutaneous Low dose, days to weeks	Decreased reproduction Increased mortality

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— QUANTIFICATION OF TOXICOLOGIC EFFECTS —

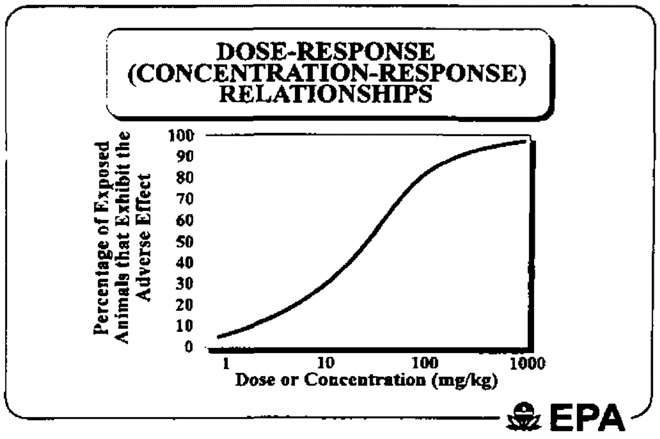
For the majority of chemicals, the likelihood that adverse effects will occur increases as the dose of the chemical and the period of exposure increase.

The relationship between the dose of a chemical and the degree of adverse effects that occur in an animal is known as a dose-response relationship.

The relationship between the aqueous concentration of a chemical and the degree of adverse effects that occur in aquatic organisms is known as a concentration-response relationship.

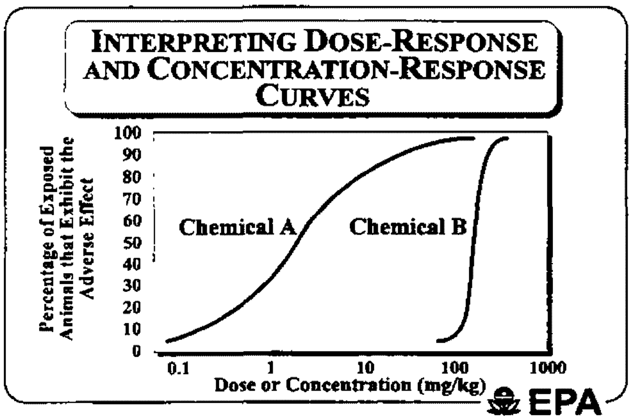
Dose-response (concentration-response) curves plot the dose (concentration) along the horizontal axis and the percentage of exposed animals exhibiting the adverse effect along the vertical axis.

Slide 12: Dose-Response Relationships



By plotting curves of two chemicals on a single graph, it is possible to compare the relative toxicity of the two chemicals.

Slide 13: Interpreting Dose-Response Curves

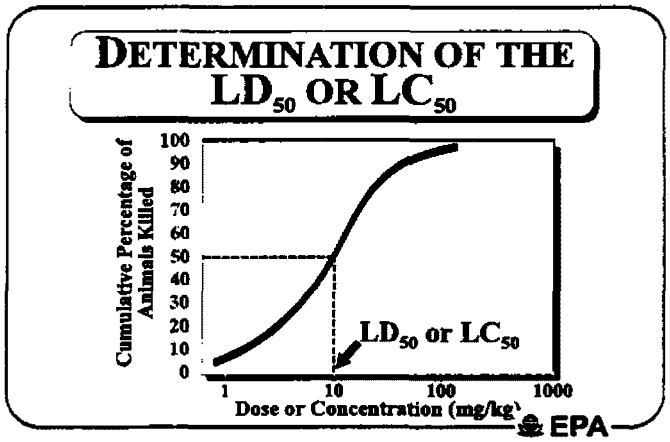


LD_{50} tests with mammals or birds are used to measure the acute toxicity of a chemical by identifying the dose that kills 50 percent of the animals exposed to the chemical.

For chemicals that are present in water or air, a lethal concentration, or LC_{50}, may be reported.

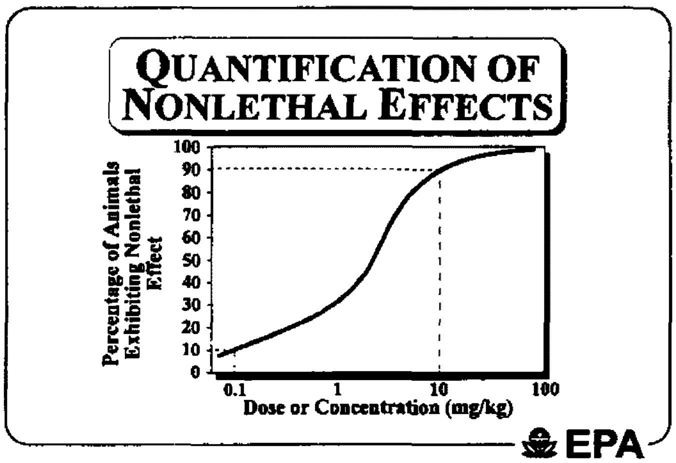
In an LD_{50} test, the adverse effect plotted on the vertical axis of the dose-response (concentration-response) graph is death.

Slide 14: Determination of the LD_{50}



When toxicologists study endpoints other than lethality, they often report results as ED_{10} or as ED_{90} — or as EC_{10} or EC_{90} values. In these values, "ED" stands for "effective dose," while "EC" stands for "effective concentration."

Slide 15: Quantification of Nonlethal Effects



Dose-response (concentration-response) studies are also used to identify levels of exposure to a chemical that can be considered relatively safe.

Slide 16: NOAEL/NOAEC

NOAEL

No-Observed-Adverse-Effect Level
Highest Experimentally Tested Dose of a Chemical That Does Not Produce Signs of Toxicity

NOAEC

No-Observed-Adverse-Effect Concentration
Similar to NOAEL, Except That Chemical Concentration in Water or Air Is Used in Place of an Administered Dose

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When it is not possible to determine a NOAEL (or NOAEC), toxicologists generally report the lowest dose or concentration tested as the LOAEL (or LOAEC).

Slide 17: LOAEL/LOAEC

LOAEL

Lowest-Observed-Adverse-Effect Level
Lowest Dose That Causes an Adverse Effect

LOAEC

Lowest-Observed-Adverse-Effect Concentration
Similar to LOAEL, Except That Chemical Concentration in Water or Air Is Used in Place of an Administered Dose

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— EVALUATION OF TOXICOLOGIC DATA —

Dose-response data can provide important information, but there are also some limitations.

Slide 18: Limitations of Dose-Response Data

LIMITATIONS OF DOSE-RESPONSE DATA

- **Paucity of Data**
- **Endpoint Selection**
- **Limits of the Dose-Response Model**

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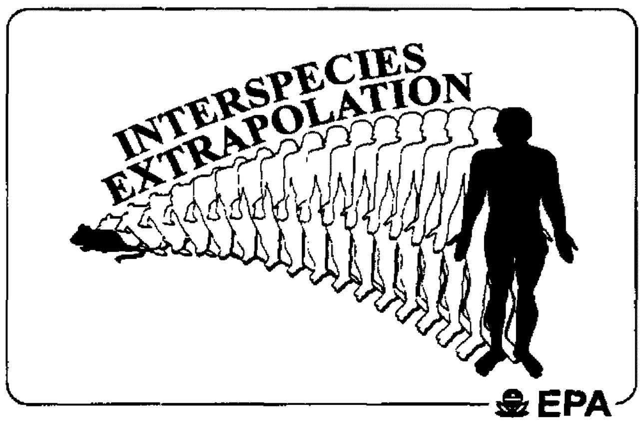
Extrapolation is the process of using assumptions to form conclusions that extend beyond the realm of experimental data.

One of the most common areas of extrapolation in mammalian toxicology is the use of animal data to predict what effects a chemical will have in humans.

Slide 19: Interspecies Extrapolation



To account for uncertainties that are inherent in efforts to apply experimental data to a real world situation, toxicologic values are usually adjusted.

Slide 20: Uncertainty Factors

UNCERTAINTY FACTORS

An Uncertainty Factor of 1, 3, or 10 is Assigned for Each of the Following:

- **Use of Animal Data to Predict Human Responses or use of surrogate species to protect endangered species**
- **Individual Variability in the Population**
- **Use of Short-Term (90-day) Studies to Predict Effects of Long-term Exposure**
- **Use of a LOAEL Rather than a NOAEL to Calculate the RfD**
- **An Inadequate Data Base or a Data Base With Gaps**

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If variables are known that will affect the likelihood of adverse effects, modifying factors are applied.

Slide 21: Modifying Factors

MODIFYING FACTORS

A Modifying Factor of 1 to 10 May be Used to Account for Known Variables, Such as:

- **Known Differences in the Absorption of a Chemical from Water Versus Food**
- **A Known Lack of a Sensitive Endpoint of Toxicity**

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The Reference Dose is an estimate of the daily exposure to a noncarcinogenic chemical that is likely to be without significant risk of harmful effects during an individual's lifetime, taking into account all of the uncertainties in the available data.

A Reference Concentration or criterion is calculated in a similar manner for aquatic organisms.

Slide 22: Calculation of the Reference Dose

$$\boxed{RfD = \frac{NOAEL}{UF \times MF}}$$

Where:

RfD = **Reference Dose**
NOAEL = **No-Observed-Adverse-Effect Level**
UF = **Uncertainty Factors**
MF = **Modifying Factors**

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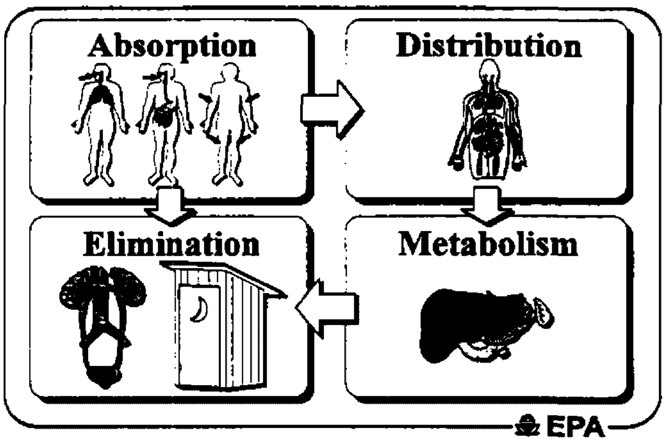
Computerized mathematical models are now being used to evaluate chemical toxicity data.

One of the most widely used data bases containing toxicity information for humans is IRIS.

— PHARMACOKINETICS —

Pharmacokinetics is the area of toxicology that studies the interactions between a chemical and an organism over time.

Slide 23: Pharmacokinetic Processes



Absorption is how a chemical enters the bloodstream.

A chemical's bioavailability is the proportion of a chemical concentration or dose that crosses the organism's body barriers and enters the bloodstream.

Distribution is the process of a chemical being carried by the blood to organs and tissue throughout the body.

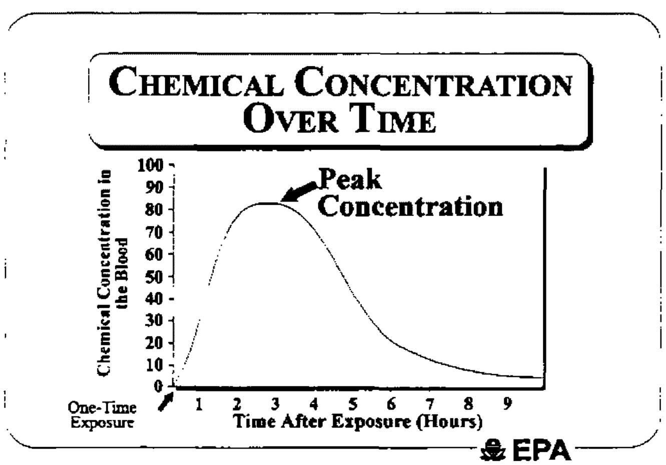
Metabolism or biotransformation is the structural changes to a chemical that occur in the body.

A metabolite is the changed form of a chemical.

The two processes of elimination are egestion (chemicals pass through the gastrointestinal tract without being absorbed in the bloodstream) and excretion (removal after being absorbed in the bloodstream).

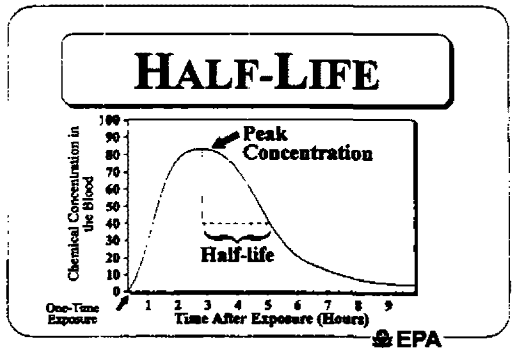
Chemical concentration in the blood is plotted on the vertical axis of a graph, and the time after exposure is plotted on the horizontal axis.

Slide 24: Chemical Concentration Over Time



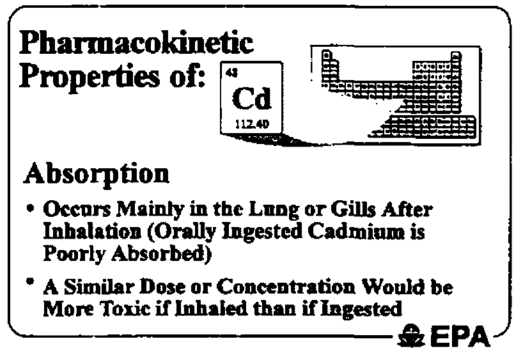
One half-life is the time it takes for the peak chemical concentration to be reduced by 50 percent.

Slide 25: Half-Life

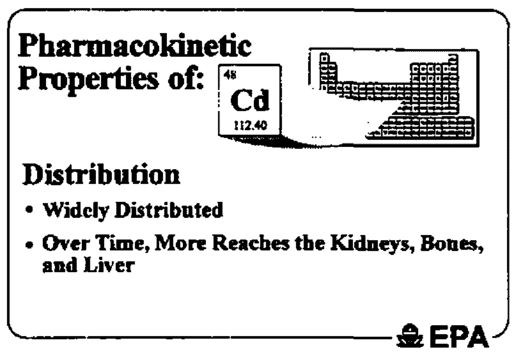


A chemical's pharmacokinetic profile can affect the toxicity of a chemical.

Slide 26: Cadmium Absorption

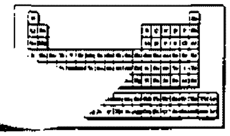


Slide 27: Cadmium Distribution



Slide 28: Cadmium Metabolism

Pharmacokinetic Properties of: 48 Cd 112.40



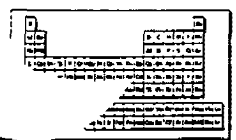
Metabolism

- Does Not Undergo Significant Metabolism
- Forms Stable Complex with Metallothionein
- Renal Toxicity Occurs when Amount in Body Exceeds Binding Capacity of Metallothionein

EPA

Slide 29: Cadmium Elimination

Pharmacokinetic Properties of: 48 Cd 112.40



Elimination

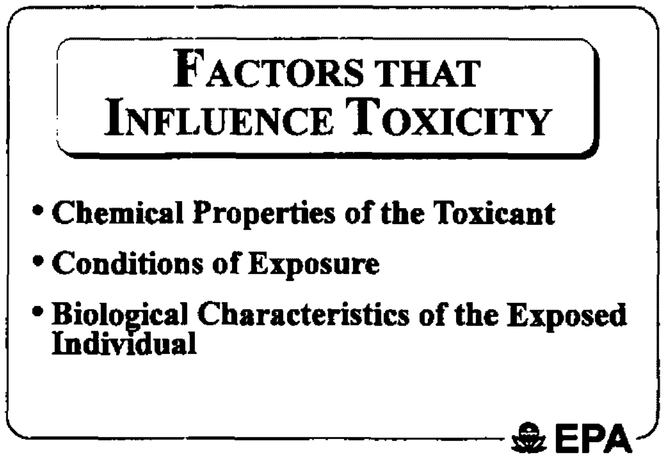
- Less than 0.01% is Excreted Each Day
- Half-Life in the Human Body as a Whole = 19-38 Years
- Half-Life in Wildlife = Unknown

EPA

— FACTORS THAT INFLUENCE TOXICITY —

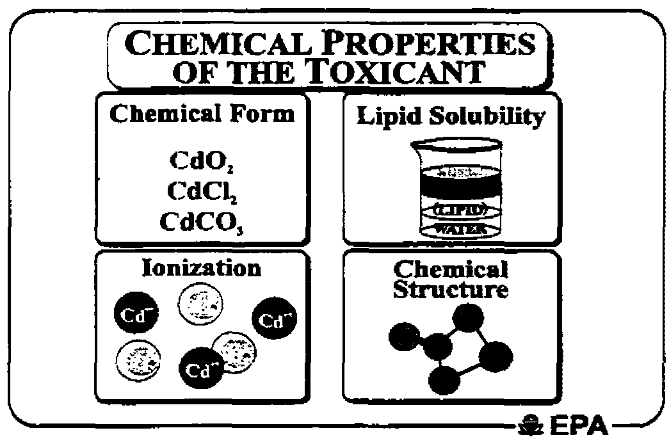
Factors that influence toxicity fall into three categories.

Slide 30: Factors That Influence Toxicity



Chemical properties that influence a compound's toxicity profile fall into different categories.

Slide 31: Chemical Properties of the Toxicant



Different forms of a chemical may differ in their ability to reach specific types of membranes.

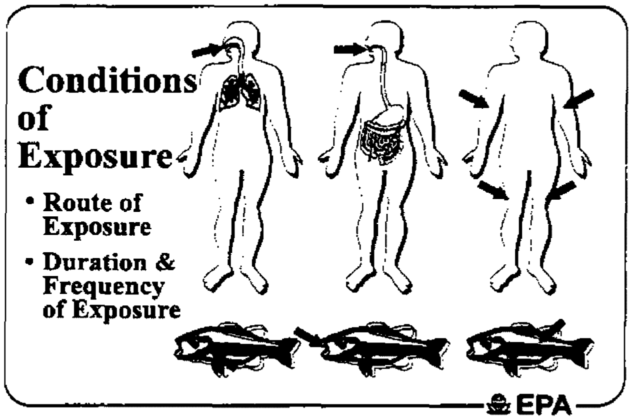
A feature that influences the ability of a toxicant to cross biological membranes is its solubility in lipid (fatty) substances.

Ionization is the process by which electrically neutral salts separate into a positively charged ion and a negatively charged ion when they are present in solution.

A toxicant's ability to cause harmful effects is closely related to its chemical structure.

Another factor that influences a chemical's toxicity profile is related to the conditions under which exposure to the toxicant occurs.

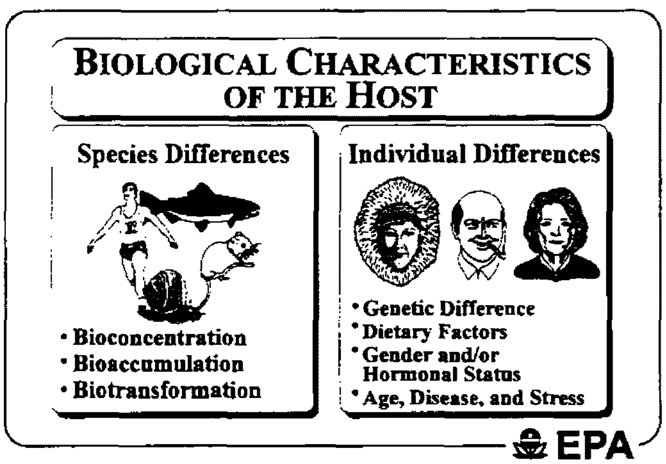
Slide 32: Conditions of Exposure



A chemical's toxicity profile can also be influenced by the duration, route, and frequency of exposure.

The third major category of factors that influence a chemical's toxicity profile are factors related to the biological characteristics of the host.

Slide 33: Biological Characteristics of the Host



Bioconcentration is the net accumulation of a substance by an aquatic organism as a result of uptake directly from the ambient water through gill membranes or other external body surfaces.

Bioaccumulation is the net accumulation of a substance by an organism as a result of uptake from all environmental sources.

Metabolic differences (biotransformations) may make it difficult to form meaningful conclusions about a toxicant's risk to humans on the basis of animal data.

Factors that account for intraspecies variability include:

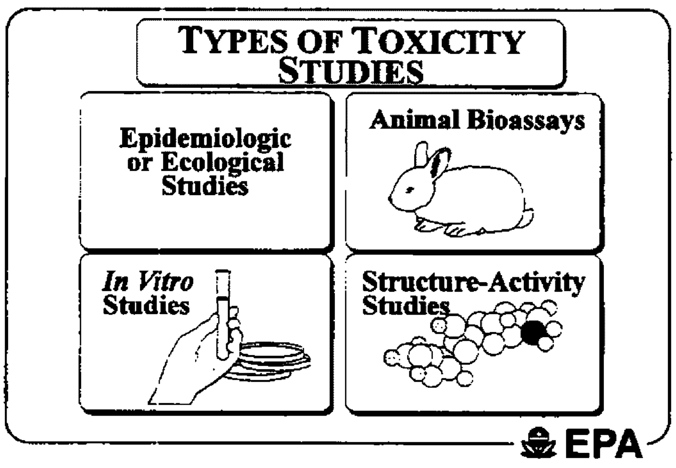
- genetic differences;
- dietary factors;
- gender or hormonal status; and
- age, disease, and stress.

— STUDIES OF CHEMICAL TOXICITY —

Evidence of a chemical's potential to produce adverse effects in humans is usually gathered in a variety of ways.

Four types of studies are most commonly used to characterize a chemical's toxicity to humans.

Slide 34: Types of Toxicity Studies



Epidemiology is the study of disease and factors that contribute to disease in humans.

Slide 35: Epidemiologic Studies

Advantage:

Uses Human Data

Epidemiologic Studies

Limitations:

- Often Based on Accidental or Occupational Exposures
- Don't Establish Causality
- Existing Studies are Not Well-Controlled
- Expensive to Conduct

EPA

For terrestrial and aquatic wildlife, field studies using ecological investigation methods can help detect factors that adversely affect these organisms, and hence, cause disease.

Slide 36: Epidemiologic Studies

Advantage:

- Uses Data From Aquatic and Terrestrial Wildlife exposed *In Situ*

Ecological Studies

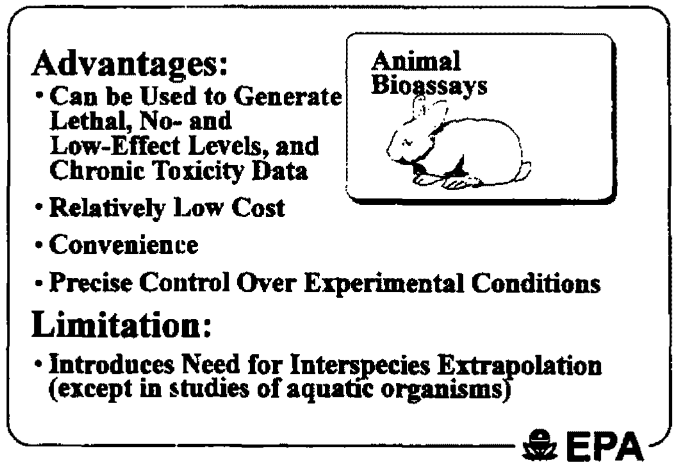
Limitations:

- Sources of Exposure can be Accidental, Deliberate, or Unknown.
- Can be Difficult to Distinguish Natural Variability from Effects of Anthropogenic Contaminants.
- Monitoring and Other Studies Need To Be Focused To Be of Most Value.

EPA

In an animal bioassay, known quantities of a toxicant are administered to laboratory animals and the animals' responses are monitored.

Slide 37: Animal Bioassays



Acute toxicity studies are conducted to examine the effects of exposure to one or a few large doses of the test chemical.

Subchronic toxicity studies involve daily administration of low to moderate doses for an extended period of time.

Chronic toxicity studies involve daily administration of a toxicant, usually at low doses, for a longer period of time.

Bioconcentration studies involve continuous exposure of aquatic organisms to sublethal concentrations of a toxicant.

In whole-effluent toxicity tests, samples of industrial or municipal effluents are collected and diluted with varying concentrations of uncontaminated water.

Slide 38: Animal Bioassays

BIOASSAYS

EPA

In vitro studies usually involve observing a chemical's effects in a cell culture or tissue preparation.

Slide 39: *In Vitro* Studies

Advantages:

- **Offer Insight into Toxicant's Mechanism of Toxicity**
- **Rapid and Inexpensive**
- **Can be Used to Screen Potential Toxicants for Further Study**

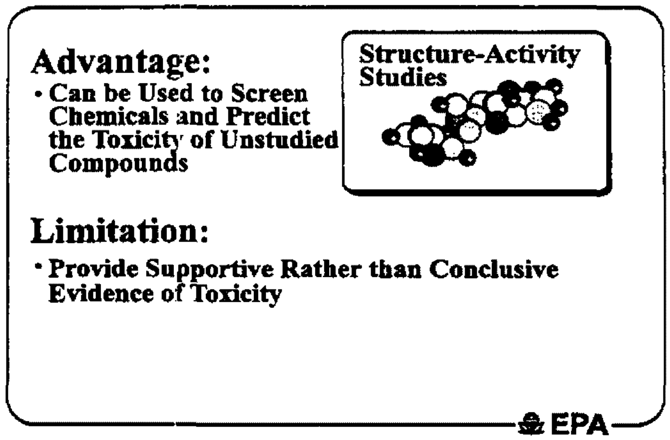
Limitations:

- **Not Conducted in Living Animals**
- **Provide Supportive Rather than Conclusive Evidence of Toxicity**

EPA

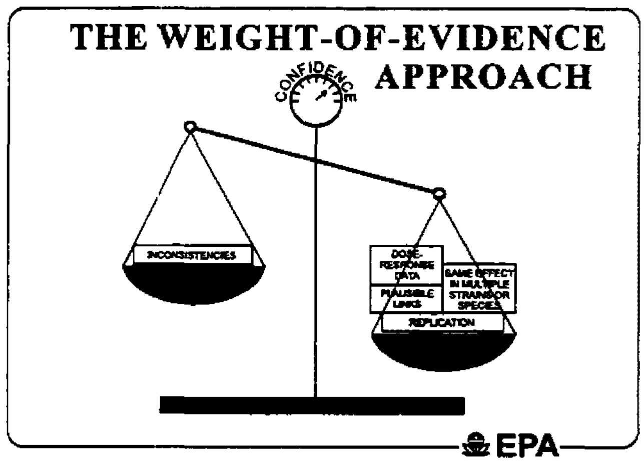
Structure-activity studies compare the relative toxicity of structurally related compounds.

Slide 40: Structure-Activity Studies



In the weight-of-evidence approach, elements of the data base are weighted differently based on the extent to which they contribute to a plausible and consistent picture of toxicity.

Slide 41: Weight-of-Evidence Approach



REVIEW QUESTIONS

1. The toxicologic endpoint that refers to the ability of a toxicant to cause cancer is:

   a. immunotoxicity
   b. neurotoxicity
   c. carcinogenicity
   d. reproductive toxicity

2. Adverse effects that disappear when the toxicant is removed from the body are called:

   a. reversible effects
   b. irreversible effects
   c. threshold effects
   d. nonthreshold effects

3. Dose-response tests can provide information about all of the following properties of a chemical EXCEPT:

   a. its relative potency
   b. its lethal and nonlethal doses
   c. its NOAEL/NOAEC and LOAEL/LOAEC
   d. its concentrations in the environment

4. True or False. To account for the uncertainties involved in applying experimental data to real world situations, toxicologists usually divide toxicologic values (such as the NOAEL or LOAEL) by one or more uncertainty factors.

5. True or False. A toxicant's bioavailability is a measure of its rate of elimination from the body.

6. Chemical properties that can influence the toxicity profile of a chemical include all of the following EXCEPT:

   a. lipid solubility
   b. tendency to ionize in solution
   c. chemical structure and chemical form
   d. route, duration, and frequency of exposure

7. True or False. The main advantage of epidemiologic studies is that well-controlled studies are usually very inexpensive to conduct.

REVIEW QUESTIONS

1. True or False. Risk is defined as the likelihood of injury, disease, or death under specified conditions, while risk assessment consists of efforts to quantify this risk.

2. Which of the following is NOT one of the four components of the NAS risk assessment paradigm?

   a. hazard identification
   b. dose-response assessment
   c. exposure assessment
   d. risk characterization
   e. risk communication

3. The goal of the hazard identification step in a risk assessment is to determine:

   a. whether a hazard exists
   b. how severe the hazard is
   c. how prevalent the hazard is
   d. how likely it is that the hazard will occur

4. True or False. To ensure consistency across dose-response assessments, risk assessors use one method to analyze all dose-response data.

5. The two main types of studies used in exposure assessment are:

   a. epidemiologic and animal studies
   b. monitoring and modeling studies
   c. *in vitro* and structure-activity studies
   d. acute and chronic toxicity studies

6. True or False. In a risk characterization for a non-carcinogen, we are most concerned if the reference dose is higher than the estimated exposure dose (if RfD > EED).

TRAINING MODULE 7:
INTRODUCTION TO CRITERIA DEVELOPMENT

MODULE SUMMARY:

This module provides an introduction to the different types of water quality criteria and sets the stage for the next four modules.

OVERALL OBJECTIVES:

To attain an understanding of the different categories of water quality criteria and how they work together to achieve the objective of the Clean Water Act: "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."

MEASURABLE OBJECTIVES:

After completing this module, participants should be able to:

- Explain the relationship between water quality criteria and water quality standards
- Explain the difference between numeric and narrative criteria
- Identify the different categories of water quality criteria
- Explain how the different criteria work together to achieve the goals of the Clean Water Act

LOGISTICS:

Teaching Method: Lecture (with vugraphs); Video.

Approximate Presentation Time: 35 minutes (Lecture—20 minutes; Video—15 minutes).

Basic Course Reference Manual Documents:

1 Clean Water Act: sections 104(n)(1); 301; 303; 304(a); 402; 404.

4 Water Quality Standards Handbook, Second Edition, August 1994.
Appendix A: Water Quality Standards Regulation: 40 CFR 131.11.
Appendix I: List of EPA Water Quality Standards Criteria Documents.
Appendix P: List of 126 Section 307(a) Priority Toxic Pollutants.

Other Documents:

Quality Criteria for Water (the Gold Book), Office of Water Regulations and Standards. 1987.

REVIEW QUESTIONS

1. Which of the following is not a typical element of a health assessment?

   a. exposure
   b. pharmacokinetics
   c. biological endpoints
   d. toxic effects
   e. criterion formulation

2. True or False. Section 304(a)(l) criteria are regulatory limits States are required to achieve.

3. True or False. The toxic effects section of health assessments includes data reviews on absorption, distribution, metabolism, and excretion.

4. True or False. The RfD is a threshold value below which noncarcinogenic toxic effects are unlikely to occur.

5. The Carcinogenic Potency Slope factor is _____.

   a. RL
   b. RfD
   c. BCF
   d. q_1*
   e. BAF

6. The uptake of a chemical through the food chain and water is the ________.

   a. Food Chain Multiplier
   b. Bioaccumulation Factor
   c. Bioconcentration Factor
   d. RfD
   e. q_1*

7. True or False. Even if an EPA criterion is not available, a reference ambient concentration (RAC) can be calculated.

8. An electronic online data base of the U.S. EPA which is the accepted source for RfD values is ________.

   a. BAF
   b. BCF
   c. RfD
   d. IRIS
   e. q_1*

REVIEW QUESTIONS

1. Which of the following is not necessary when deriving numerical water quality criteria for protection of aquatic life?

   a. Aquatic toxicity tests that conform to ASTM standards
   b. Hard copy documentation of all tests used
   c. Carcinogenic rodent bioassays of material in question
   d. Specific definition of chemical/material of concern

2. Which of the following is true in regard to the calculation of the Final Chronic Value?

   a. A Final Chronic Value can always be calculated
   b. The Final Acute Value may be a component of the Final Chronic Value
   c. The Final Chronic Value is equal to half the Final Acute Value
   d. The Criterion Continuous Concentration always equates to the Final Chronic Value

3. True or False. If species sensitivity at a site is similar and physical or chemical properties affect bioavailability, the recalculation procedure is used.

4. Which of the following would not be a reason for establishing a site-specific criterion?

   a. Water quality characteristics of a site are known to vary greatly from season to season.
   b. The pollutant in question is a metal. The site in question has high levels of total organic carbon, which is known to bind various species of the metal pollutant being regulated.
   c. A stream contains an aquatic invertebrate that is unusually resistant to various pollutants.
   d. Physical and chemical characteristics at the site have no effect on the toxicity and bioavailability and the range of resident species sensitivities is comparable to those species in the national criterion document.
   e. None of these (a-d) is a reason.

TRAINING MODULE 10:
SEDIMENT CRITERIA

MODULE SUMMARY:

This module discusses the importance of sediment criteria, approaches to establishing sediment criteria, and sections of the Clean Water Act where sediment criteria apply (or can apply).

OVERALL OBJECTIVES:

To provide an understanding of the methodology used to develop sediment criteria, and how sediment criteria can be used to protect the aquatic environment.

MEASURABLE OBJECTIVES:

After completing this module, participants should be able to:

- Define sediment
- Identify reasons why contaminated bottom sediments pose a severe environmental problem
- Identify six activities concerning contaminated sediments that should be addressed under a successful management program
- Explain the role of bioavailability in developing sediment quality criteria
- Define the equilibrium partitioning approach that EPA is using to develop sediment criteria
- List the classes of contaminated sediments that EPA's sediment criteria will initially delineate
- Identify potential applications of sediment criteria

LOGISTICS:

Teaching Method: Lecture (with vugraphs).

Approximate Presentation Time: 1¼ hour (Lecture—50 minutes, Class Exercise—20 minutes; Review Questions—15 minutes).

Basic Course Reference Manual Documents:

1 Clean Water Act: sections 303; 304(a); 402; 404.

3 Water Quality Standards Handbook. Second Edition. September 1993, Chapter 3.

16 Briefing Report to Science Advisory Board on the Equilibrium Partitioning Approach to Predicting Metal Bioavailability in Sediment and the Derivation of Sediment Quality Criteria for Metals. December 1994.

17 Memo to Carol Browner from SAB in regard to SAB review of Agency's Approach for the development of sediment criteria for 5 metals. September 29, 1995.

18 Memo from Carol Browner to SAB in response to SAB Review of Agency's Approach for development of sediment criteria for 5 metals. February 2, 1996.

Other Documents:

Briefing Report to the EPA Science Advisory Board on the Equilibrium Partitioning Approach to Generating Sediment Quality Criteria. U.S. Environmental Protection Agency. April 1989. EPA 440/5-89-002.

Managing Contaminated Sediments: EPA Decision-Making Processes. U.S. Environmental Protection Agency, Sediment Oversight Technical Committee. December 1990. EPA 506/6-90/002.

Sediment Classification Methods Compendium. U.S. Environmental Protection Agency, Watershed Protection Division. September 1992, EPA 822-R-92-006.

Contaminated Sediments: Relevant Statutes and EPA Program Activities. U.S. Environmental Protection Agency, Sediment Oversight Technical Committee. December 1990. EPA 506/6-90/003.

Sediment Quality Criteria for the Protection of Benthic Organisms: ACENAPHTHENE. September 1993. EPA-822-R-93-013.

Sediment Quality Criteria for the Protection of Benthic Organisms: DIELDRIN. September 1993. EPA-822-R-93-015.

Sediment Quality Criteria for the Protection of Benthic Organisms: ENDRIN. September 1993. EPA-822-R-93-016.

Sediment Quality Criteria for the Protection of Benthic Organisms: FLUORANTHENE. September 1993. EPA-822-R-93-012.

Sediment Quality Criteria for the Protection of Benthic Organisms: PHENANTHRENE. September 1993. EPA-822-R-93-014.

Report of the Sediment Criteria Subcommittee of the Ecological Processes and Effects Committee - Evaluation of the Equilibrium Partitioning Approach for Assessing Sediment Quality.

Analytical Method for Determination of Acid Volatile Sulfide in Sediment (final draft). U.S. Environmental Protection Agency.

Sediment Quality Criteria Methodology Validation: Uncertainty Analysis of Sediment Normalization Theory for Non-polar Organic Contaminants. U.S. Environmental Protection Agency.

Guidelines for Deriving Site-Specific Sediment Quality Criteria for the Protection of Benthic Organisms. September, 1993. EPA-822-R-93-017.

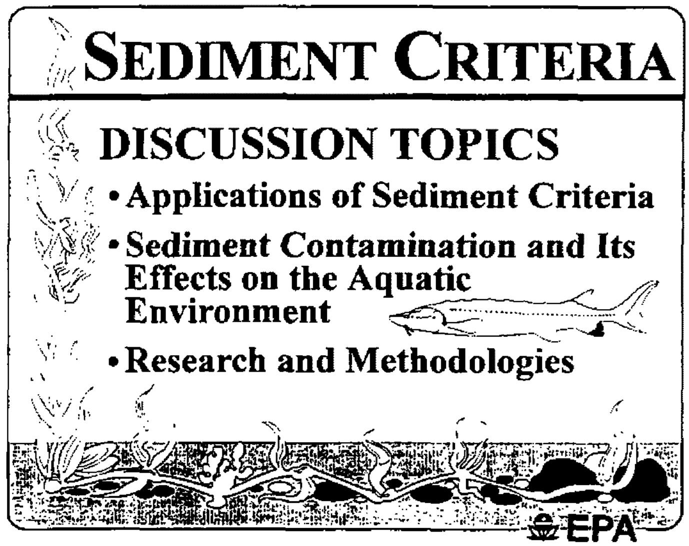
Technical Basis for Deriving Sediment Quality Criteria for Non-ionic Organic Contaminants for the Protection of Benthic Organisms by Using Equilibrium Partitioning. September 1993. EPA-822-R-94-011.

MODULE 10 - OUTLINE
SEDIMENT CRITERIA

— INTRODUCTION —

Contaminated sediments can pose serious threats to human health and the environment.

Vugraph 1: Discussion Topics



Sediment consists of organic and nonorganic material that has settled at the bottom of a waterbody.

Historically, point source discharges of heavy metals, PCBs, pesticides, dioxins, and other contaminants were the main source of contaminants in pollutants.

Vugraph 2: Point Source Categories

POINT SOURCES OF POLLUTION

Include Discharges from:

- **Industries**
- **Wastewater Treatment Plants**
- **Combined Sewers**

EPA

A more recent concern is the impact of pollutants derived from nonpoint sources such as runoff from agricultural activities, construction sites, and urban areas.

Vugraph 3: Nonpoint Source Categories

NONPOINT SOURCES OF POLLUTION

Include Runoff from:

- **Agricultural Activities**
- **Construction Sites**
- **Urban Areas**

EPA

The contamination of sediments is influenced by a number of variables.

Vugraph 4: Variables

VARIABLES INFLUENCING SEDIMENT CONTAMINATION

- **Contaminant Source**
- **Contaminant Type**
- **Sedimentary and Hydrologic Environment**
- **Grain Size Distribution and Composition**
- **Aquatic Life**
- **Historical Influences**

EPA

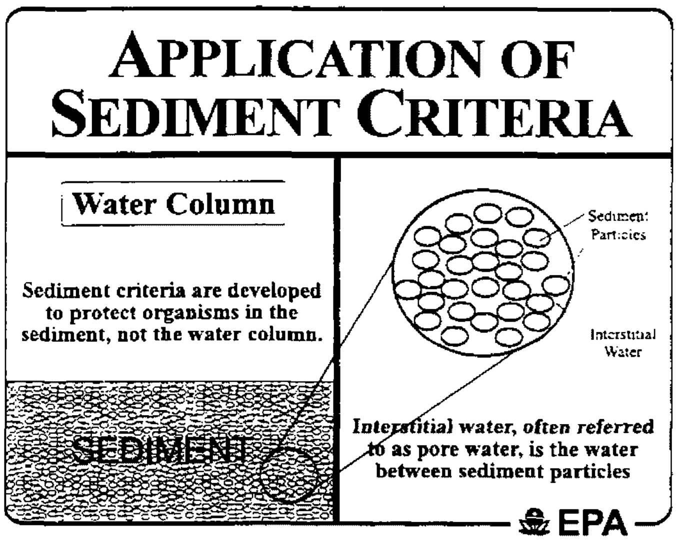
Sediment contamination is not necessarily connected to poor water quality.

— APPLICATIONS OF SEDIMENT CRITERIA —

The Clean Water Act provides EPA with the authority to develop sediment criteria.

Sediment criteria apply only to the sediment itself and the interstitial water.

Vugraph 5: Application of Sediment Criteria



— MANAGEMENT OF SEDIMENT ISSUES —

Management programs need to consider the entire "sediment package".

Vugraph 6: Management Program

MANAGEMENT PROGRAM

- **Management Strategy**
- **Users Guide**
- **Sediment Criteria**
- **Target Sites**
- **Sediment Toxicity Testing**
- **Guidance Document**

EPA

A comprehensive management program includes 6 key activities.

Vugraph 7: Sediment Management Activities

MANAGEMENT ACTIVITIES

1. **Finding Contaminated Sediments**
2. **Assessment of Contaminated Sediments**
3. **Prevention and Source Control**
4. **Remediation**
5. **Treatment of Removed Sediments**
6. **Disposal of Removed Sediments**

EPA

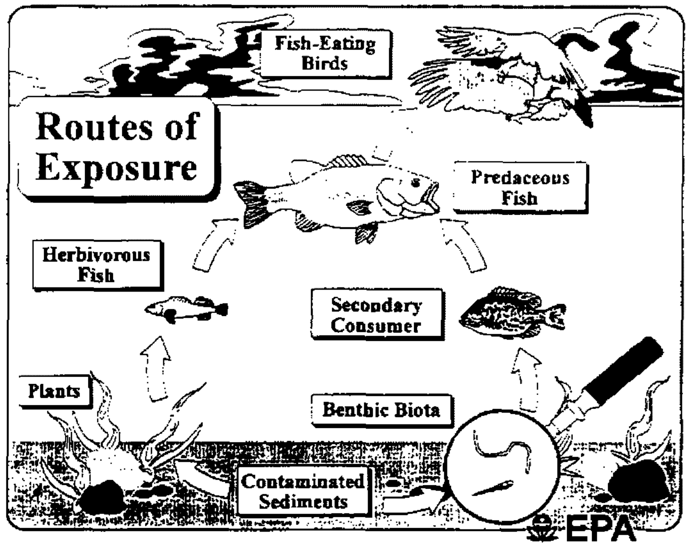
— CLASS EXERCISE —

— BIOLOGICAL EFFECTS OF CONTAMINATED SEDIMENTS —

Research has determined that sediments in aquatic environments have the ability to accumulate or absorb higher concentrations of pollutants than the overlying waters.

Aquatic organisms are exposed to concentrations through a variety of pathways.

Vugraph 8: Aquatic Environment



The primary technical difficulty that must be overcome in establishing sediment quality criteria is to determine the extent of bioavailability of sediment-associated chemicals.

Vugraph 9: Bioavailability

TOXICITY AND BIOAVAILABILITY

Similar Concentrations of a Chemical Can Produce Widely Different Biological Effects in Different Sediments

EPA

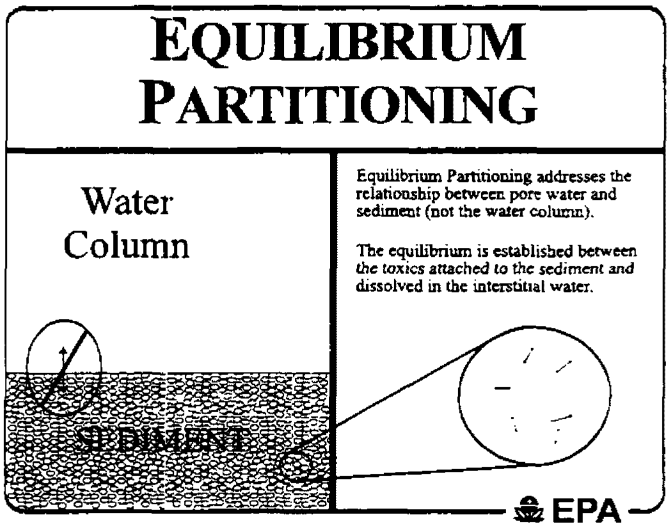
The concentration-response curve for the biological effect of concern can be correlated not to the total sediment-chemical concentration, but to the interstitial water concentration.

— EQUILIBRIUM PARTITIONING —

Sediment criteria development activities have centered on evaluating and developing the equilibrium partitioning approach.

Equilibrium partitioning involves the balancing of a pollutant concentration between the sediment and the associated interstitial water.

Vugraph 10: EqP



Chemical components of water should be measured because these factors may affect the toxicity of sediment contaminants.

The equilibrium partitioning method was selected because it has been shown to accurately predict toxicity and environmental effects.

EPA has developed a methodology for deriving sediment quality criteria for non-ionic, or non-polar, organic contaminants. Methodology and criteria for metals are currently under development.

Numeric values for sediment quality criteria (SQC) are derived by a back-calculation from the chemical-specific chronic water quality criterion (the effects concentration of a chemical on benthic organisms).

Vugraph 11 and 12: Parameters Used to Calculate SQCs

SQC CALCULATION PARAMETERS

K_{ow}: Specific chemical's octanol/water partitioning coefficient; a measure of the chemical's differential solubility in organic and aqueous solutions.

K_{oc}: Organic Carbon-normalized partitioning coeffieient; a measure of a chemical's differential solubility between the sediment and the interstitial water.

EPA

SQC CALCULATION PARAMETERS (cont'd.)

F_{OC}: Fraction Organic Carbon

FCV: Final Chronic Value

EPA

Chronic water quality criteria are the effects concentration from which a solid phase (organic carbon normalized) effects concentration can be calculated.

Vugraph 13: Basic Calculation of SQCs

SQC CALCULATION

$$SQC_{oc} = FCV \times K_{oc}$$

or

$$SQC = (SQC_{oc})(F_{oc})$$

EPA

The applicability of this methodology depends on certain assumptions.

Vugraph 14: Non-polar Organic Constituents

NONPOLAR ORGANIC CONSTITUENTS ASSUMPTIONS

- **Pollutant Concentration in Sediment Particulates Is at Equilibrium with Sediment Interstitial Water**
- **Absorption Controlled by Chemical and Physical Properties**

EPA

Metals sediment quality criteria will be used with aquatic life criteria to protect aquatic organisms and their environment.

EPA is focusing on identifying and understanding the role of acid volatile sulfides (AVS) and other binding factors, such as organic carbon content, in controlling the bioavailability of metal contaminants.

In January 1994, EPA proposed the following: dieldrin, endrin, acenaphthene, flouranthene and phenanthrene.

Vugraph 15: Schedule for Sediment Quality Criteria (SQC) Non Ionic Organics

PROPOSED JANUARY 1994

- Dieldrin
- Endrin
- Acenaphthene
- Flouranthene
- Phenanthrene

EPA

In the Spring of 1997, EPA will finalize criteria for dieldrin and endrin only.

Vugraph 16: Schedule for Sediment Quality Criteria (SQC) Non Ionic Organics (cont.)

FINALIZE SPRING 1997

- Dieldrin
- Endrin

EPA

Proposed SQC for PAH mixtures.

Vugraph 17: Schedule for Sediment Quality Criteria (SQC) Non Ionic Organics (cont.)

PROPOSE
1998

- **PAH Mixtures Criterion**

EPA

EPA has developed a methodology for developing sediment criteria for several metal contaminants.

Vugraph 18: SQC for Metals

METHODOLOGY FOR DEVELOPING SEDIMENT CRITERIA FOR METAL CONTAMINANTS

- **Lead**
- **Nickel**
- **Copper**
- **Cadmium**
- **Zinc (divalent and cationic metals)**
- **Focus on identifying/understanding role of Acid Volatile Sulfides (AVS)**

EPA

The application of sediment criteria may vary significantly from the application of water quality criteria.

Initially, sediment criteria will be used to delineate three classes of specific sediments.

Vugraph 19: Sediment Classes

SEDIMENT CLASSES

Sediments with Contaminant Concentrations:

- **Above Criteria Levels**
- **Below Criteria Levels**
- **At or Near Criteria Levels**

EPA

Because the sediment quality criteria methodology relies on an empirical model, there is a level of uncertainty.

All sediment evaluation procedures require some level of interpretation.

— BIOCONCENTRATION/BIOACCUMULATION —

Another impact from contaminated sediment is bioconcentration and bioaccumulation.

Vugraph 20: Bioconcentration/Bioaccumulation

BIOCONCENTRATION/ BIOACCUMULATION

Bioconcentration: accumulation of waterbourne contaminants through nondietary routes

Bioaccumulation: accumulation of toxics from exposure to contaminated sediment or through the food chain

EPA

REVIEW QUESTIONS

1. Why do contaminated bottom sediments potentially pose a severe environmental problem?

   a. Because pollutants can accumulate at higher concentrations in sediments than in the water column.
   b. Because pollutants remain available for reintroduction into the water long after initial deposition.
   c. Because pollutants multiply in bottom sediments.
   d. Both a & b.
   e. All of these (a-c).

2. True or False. Sediment criteria are specifically contained in the Clean Water Act.

3. True or False. Nonpoint sources contribute to sediment contamination.

4. Determining the ______ of a chemical is critical in establishing sediment quality criteria.

   a. Bioaccumulation
   b. Bioavailability
   c. Bioconcentration

5. Sediment criteria development activities have centered on evaluating and developing the _______ approach.

   a. Non-polar complexation
   b. Equilibrium partitioning
   c. Tissue Residue
   d. Biological effects

6. EPA is in the process of developing a strategy for addressing bioaccumulative contamination in sediments and the water column by developing:

   a. Prey quality criteria
   b. Human life criteria
   c. Toxic quality criteria
   d. Worm quality criteria

7. The first sediment criteria developed will enable the user:

   a. To delineate three specific levels of sediment contamination
   b. To distinguish point source discharges
   c. To distinguish nonpoint source pollutants
   d. To fine polluters

TRAINING MODULE 11:
BIOLOGICAL CRITERIA

MODULE SUMMARY:

This module provides an overview of the biological criteria program.

OVERALL OBJECTIVES:

To provide an understanding of the meaning, value, and applications of biological criteria within water quality management.

MEASURABLE OBJECTIVES:

After completing this module, the participants should be able to:

- Describe the relationship between biological criteria and other criteria programs
- Define biological criteria
- List the steps required to implement a biological criteria program
- Identify the components of research required to develop biological criteria

LOGISTICS:

Teaching Method: Lecture (with slides); Class exercise; Video.

Approximate Presentation Time: 1¾ hours (Lecture—60 minutes; Class Exercise—20 minutes; Video—20 minutes; Review Time—15 minutes).

Basic Course Reference Manual Documents:

1 Clean Water Act: sections 303; 304(a)(8).

4 Water Quality Standards Handbook, Second Edition, August 1994.
   Chapter 3: Water Quality Criteria
   Appendix C: Biological Criteria: National Program Guidance for Surface Waters, April 1990.
   Appendix K: Procedures for the Initiation of Narrative Biological Criteria, October 1992.
   Appendix R: Policy on the Use of Biological Assessments and Criteria in the Water Quality Program, May 1991.

Other Documents:

Transmittal of Final Policy on Biological Assessments and Criteria (Memorandum). U.S. Environmental Protection Agency, Office of Water. From Tudor T. Davies, Director, Office of Science and Technology to Waste Management Division Directors, Regions I-X. June 19, 1991.

Biological Criteria: State Development and Implementation Efforts. U.S. Environmental Protection Agency, Office of Water. July 1991. EPA-440/5-91-003.

Biological Criteria: Research and Regulation—Proceedings of a Symposium. U.S. Environmental Protection Agency, Office of Water. July 1991. EPA-440/5-91-005.

Biological Criteria: Guide to Technical Literature. U.S. Environmental Protection Agency, Office of Water. July 1991. EPA/5-91-004.

Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish. U.S. Environmental Protection Agency, Office of Water. May 1989. EPA/444/4-89-001.

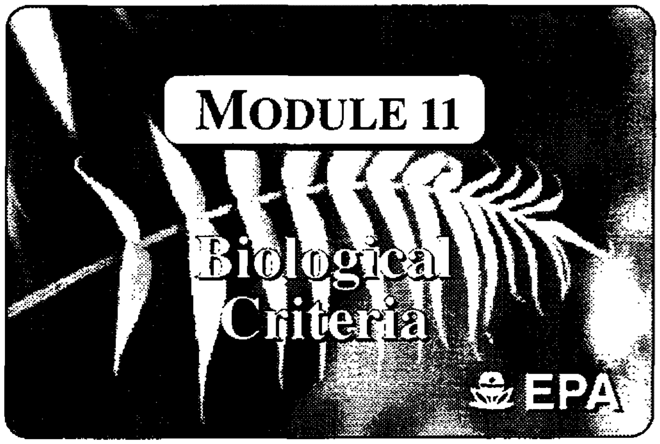
Regionalization as a Tool for Managing Environmental Resources. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR. July 1989. EPA/600/3-89/060.

MODULE 11 - OUTLINE
BIOLOGICAL CRITERIA

— INTRODUCTION —

Biological criteria are threshold levels or regulatory guidelines based on the premise that the condition of biota inhabiting waterbodies provides a useful baseline measure of water resource quality.

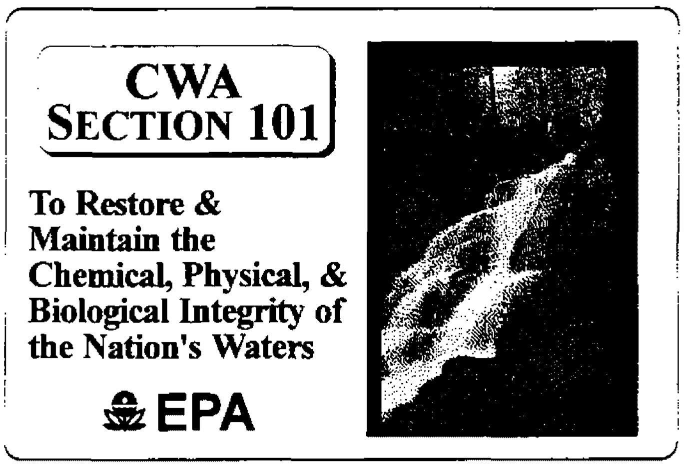
Slide 1: Introduction



— BACKGROUND —

Comprehensive information about the biological integrity of aquatic environments is needed.

Slide 2: CWA Objectives

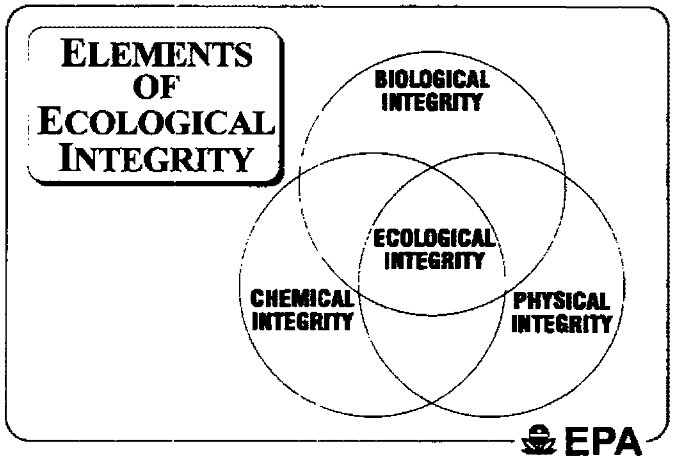


Clean Water Act (CWA) section 303(c)(2)(A) — Requires adoption of water quality standards that serve the purpose of section 101.

CWA section 303(c)(2)(B) — Where numeric criteria are not available, States should adopt criteria based on biological assessment and monitoring methods.

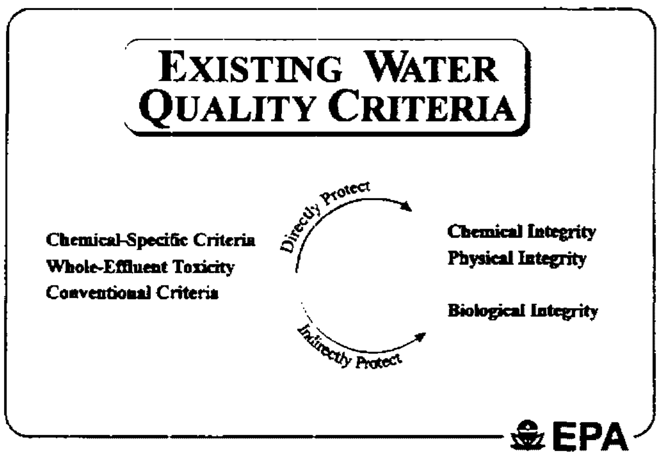
Ecological integrity is ideally attained when chemical, physical, and biological integrity occur simultaneously.

Slide 3: Ecological Integrity



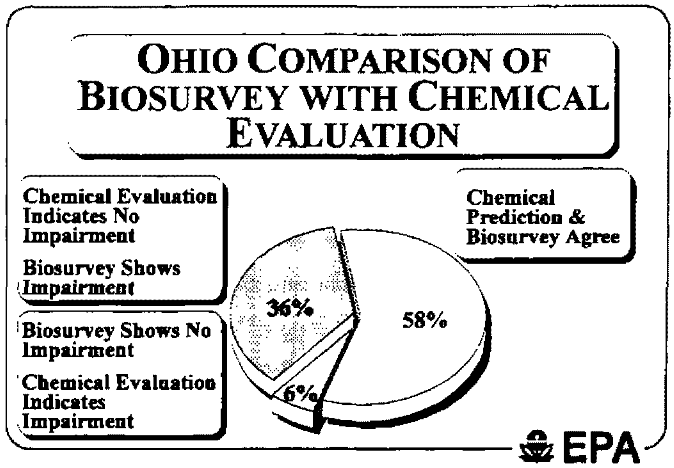
Limits to chemical-specific criteria and whole-effluent toxicity criteria.

Slide 4: 3 Elements with Current Criteria



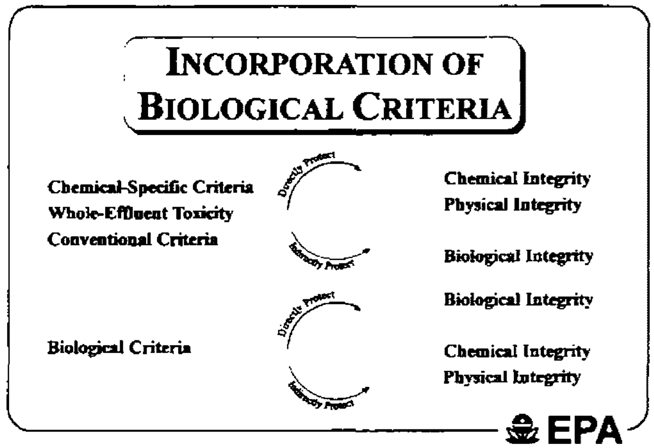
Analyses reflect the difficulty of protecting waterbodies when criteria cannot be developed for all possible chemicals.

Slide 5: Ohio Piechart



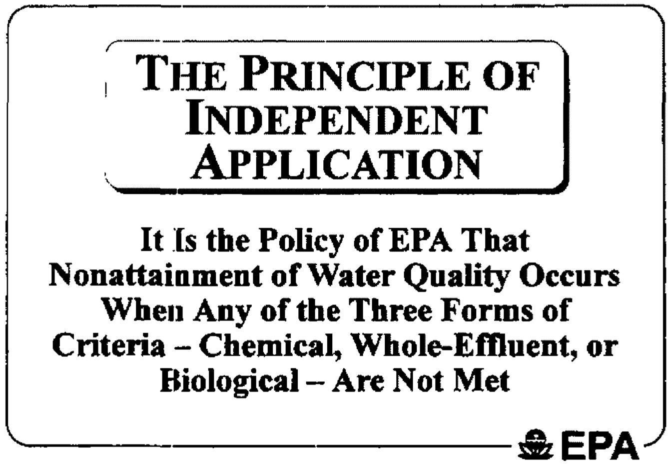
Biological assessment and criteria provide an essential third element for water quality management.

Slide 6: 3 Elements of Biological Criteria



Biological criteria supplement, but do not replace, chemical and toxicological methods.

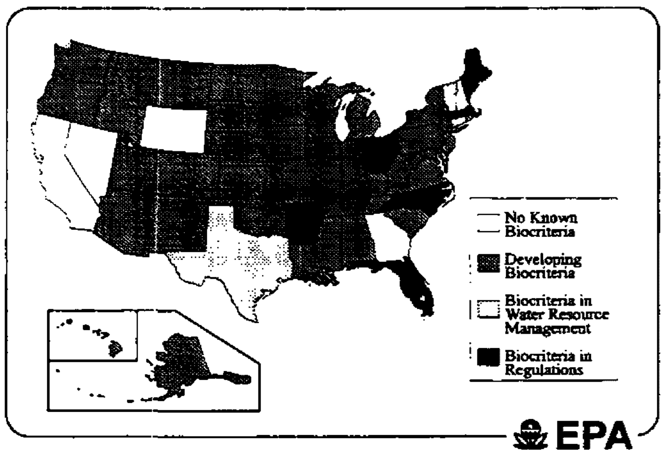
Slide 7: Independent Application



— STATUS OF STATE EFFORTS —

Several States already have biological criteria programs in place.

Slide 8: Map of States



— CONCEPT OF BIOLOGICAL CRITERIA —

The structure and function of an aquatic biological community provide critical information about the quality of surface waters.

Slide 9: Definition

BIOLOGICAL CRITERIA

Definition:

Narrative Expressions or Numerical Values That Describe the Biological Integrity of Aquatic Communities Inhabiting Water of a Given Designated Use

EPA

Biological integrity is measured by both the structure and function of the community.

Slide 10: Functional Definition

FUNCTIONAL DEFINITION OF BIOLOGICAL CRITERIA

The Condition of the Aquatic Community Inhabiting the Essentially Unimpaired Waterbodies of a Specified Habitat as Measured by Community Structure & Function

EPA

If the measures of the existing aquatic community fail to meet the criteria, the designated use is considered impaired.

Narrative criteria establish a positive statement about what should occur within a waterbody.

Slide 11: Narrative Biological Criteria

NARRATIVE CRITERIA

Definition:

General Statements of Attainable or Attained Conditions of Biological Integrity and Water Quality for a Given Use Designation

EPA

Narrative criteria can take a number of forms but must possess essential characteristics.

Slide 12: Check List

CHECKLIST FOR NARRATIVE CRITERIA

- ☑ **Protect the Particular Aquatic Life Use**
- ☑ **Include Measurable Aquatic Community Characteristics**
- ☑ **Promote Water Quality To Protect the Most Natural Community Possible**
- ☑ **Address Conflicting Multiple Uses**
- ☑ **Protect the Most Sensitive Use and Support Antidegradation**

EPA

Several States currently use narrative criteria.

Narrative criteria can be used to refine the aquatic life use classification for a State.

Slide 13: Aquatic Life Uses

REFINING AQUATIC LIFE USE CLASSIFICATIONS

Data Collected in the Biological Criteria Program May Reveal Differences in Aquatic Communities that Warrant Separation into Different Use Classes

EPA

To derive a numeric criterion, an aquatic community's structure and function are measured using quantitative tools like metrics.

Slide 14: Numeric Biological Criteria

NUMERIC CRITERIA

Definition:

Specific Quantitative Indicators (e.g., Metrics) of Desired Biological Integrity

EPA

Numeric criteria may describe community differences.

Slide 15: Community Differences

RELATIVE MEASURES OF COMMUNITY DIFFERENCES

- **Similarity Indices**
- **Coefficients of Community Loss**
- **Comparisons of Lists of Dominant Taxa**

EPA

Numeric criteria may describe community structure.

Slide 16: Community Structure

DIRECT MEASURES OF COMMUNITY STRUCTURE

- **Species Richness**
- **Indicator Taxa**
- **Distribution of Trophic Feeding Groups**

EPA

Development of numeric biological criteria requires careful assessments of community structure and function.

The process for developing and implementing biological criteria requires a multistep approach.

Slide 17: Biological Criteria Process

PROCESS FOR THE DEVELOPMENT AND IMPLEMENTATION OF BIOLOGICAL CRITERIA

EPA

Slide 18: Steps

STEPS FOR DEVELOPING AND IMPLEMENTING BIOLOGICAL CRITERIA

1. **Develop Standardized, Consistent Protocols**
2. **Identify and Conduct Biosurveys at Unimpaired Reference Sites**
3. **Establish Biological Criteria**
4. **Conduct Biosurveys at Test Sites**
5. **Analyze Results**
6. **Monitor and Modify, as Necessary**

EPA

Standardized, consistent protocols.

Slide 19: Step 1

BIOLOGICAL CRITERIA PROCESS

1. **Develop Standardized, Consistent Protocols (Test Protocol Sensitivity)**

EPA

Establish reference conditions.

Slide 20: Step 2

BIOLOGICAL CRITERIA PROCESS

1. Develop Standardized, Consistent Protocol
2. **Identify & Conduct Biosurveys at Unimpaired Reference Sites**

EPA

Establish biological criteria.

Slide 21: Step 3

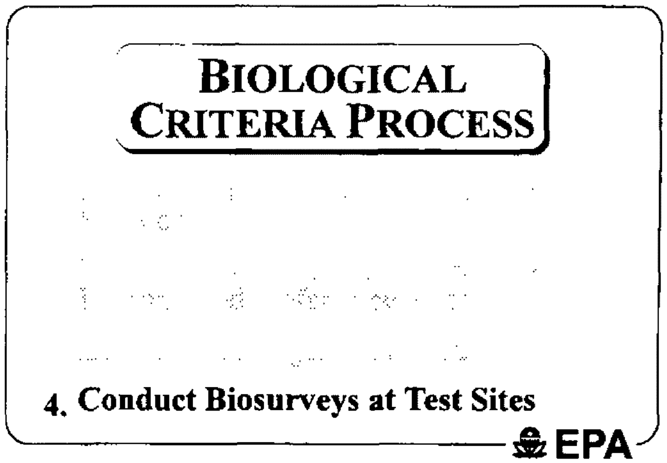
BIOLOGICAL CRITERIA PROCESS

1. Develop Standardized, Consistent Protocols
2. Identify & Conduct Biosurveys at Unimpaired Reference Sites
3. **Establish Biological Criteria**

EPA

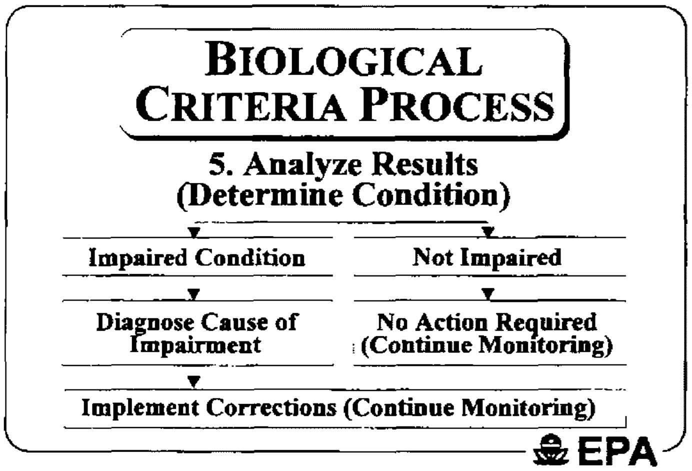
Conduct site surveys.

Slide 22: Step 4



Perform impact testing and analysis.

Slide 23: Step 5



Continue biocriteria monitoring.

Slide 24: Step 6

BIOLOGICAL CRITERIA PROCESS

6. **Continue Biocriteria Monitoring System and Review Steps 1-5 for Possible Modifications as a Result of Data Developed:**
   - **Calibration of Metrics**
   - **Revised References, Protocol, Criteria Adjustments**

EPA

— COMPONENTS OF BIOLOGICAL CRITERIA: 1. REFERENCE CONDITION —

Reference conditions are needed for environmental assessments because standard experimental controls are rarely available.

Slide 25: Component 1

COMPONENTS OF BIOLOGICAL CRITERIA

Reference Condition

EPA

Establishing a reference condition involves current investigations of selected reference sites in the context of historical conditions for these areas and the best judgement of experienced, objective biologists and natural resource managers.

Slide 26: Reference Approaches

APPROACHES TO THE DEVELOPMENT OF REFERENCE CONDITIONS

- **Site-Specific Reference Sites or Regional Reference Sites**
- **Historical Data**
- **Model-Based Approach**
- **Expert Opinion**

EPA

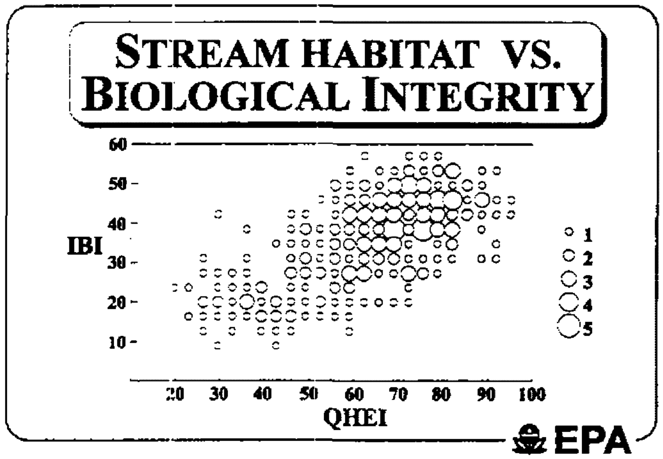
To develop the most comprehensive reference condition, ideally as much attention as is realistically possible should be paid to the reference site data. However, this data must be evaluated in the context of historical information and the collective judgment of regional experts. In some cases, such as significantly impaired areas, appropriate reference conditions must be derived primarily from that historical data, models based on site-specific knowledge, or the judgment of these experts, in order to prevent lowering the criteria by undue reliance on inappropriate reference sites.

It is important to select sites comparable in terms of habitat structure and other physical environmental parameters.

Adequate habitat evaluations need to be conducted to ensure that waterbodies with the same physical properties are compared.

A habitat assessment matrix is an example of a habitat evaluation method.

Slide 27: QHEI Graph



A site-specific reference condition is usually obtained from a nearby site on the same waterbody that is not impacted by the point discharge of interest.

A site-specific reference condition is difficult to establish when the entire waterbody is impacted or physically comparable sites are not available.

Slide 28: Site-Specific References

SITE-SPECIFIC REFERENCE CONDITIONS

Difficult To Establish When There Is:

- **Diffuse Nonpoint Source Pollution**
- **Multiple Locations of Point Sources**
- **Modification to Channel, Shoreline, or Bottom Substrate**
- **Differences in Habitat between Reference and Impact Sites**

EPA

The use of site-specific reference conditions is the method of choice for point source dischargers.

Slide 29: Drainage Pipe

The near field-far field reference condition is effective for establishing a reference condition in large lakes, estuaries, and coastal waters.

Slide 30: Near Field-Far Field

SITE-SPECIFIC REFERENCE CONDITIONS

Near Field - Far Field

Used in Estuaries and Lakes, When Large Enough To Provide for Gradient in Impact but Still Have Comparable Habitats

EPA

Regional reference conditions can also be established.

Slide 31: Paired Watersheds

REGIONAL REFERENCE CONDITIONS

- **Paired Watersheds**
- **Ecoregions**

EPA

Paired watershed reference conditions are established to evaluate waterbodies impacted by multiple sources.

Slide 32: Watershed

Reference conditions can also be developed on a larger scale.

Slide 33: Ecoregion Reference Sites

REGIONAL REFERENCE CONDITIONS

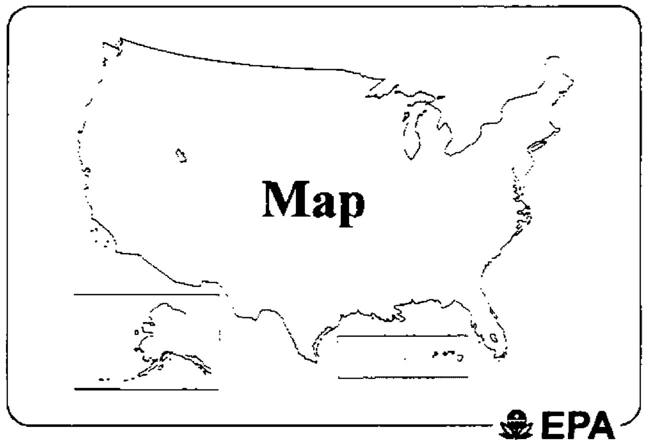
Ecoregions

Identifies Regions of Ecological Similarity from Which To Select Reference Sites

EPA

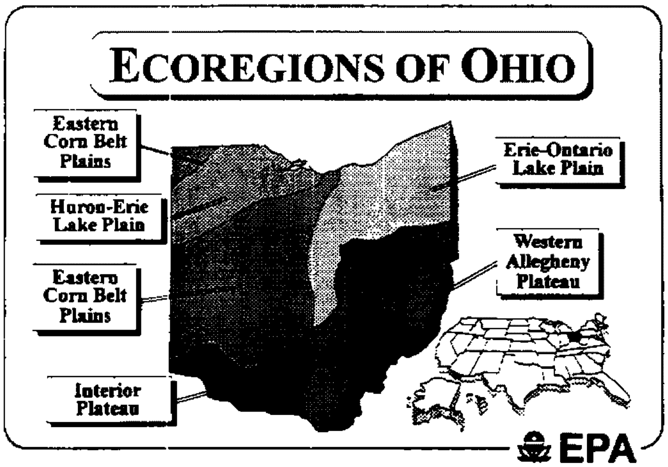
Ecoregional reference sites should be as unimpacted as possible and representative of the region's waterbodies.

Slide 34: U.S. Ecoregions



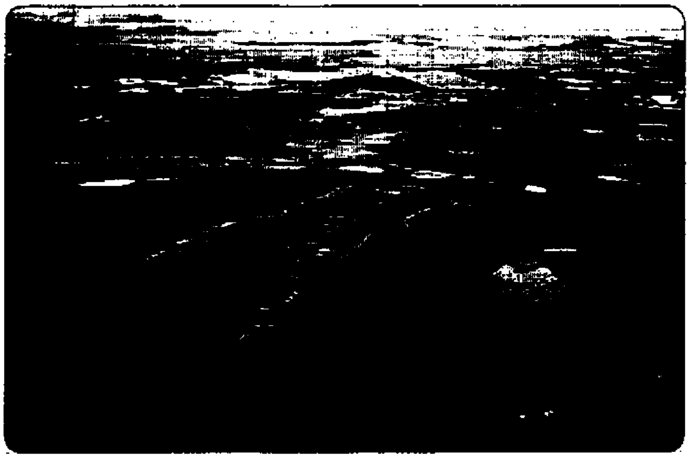
The use of ecoregions has been instrumental in the development of biological criteria.

Slide 35: Ohic Ecoregions



Candidate watersheds can be selected from appropriate maps.

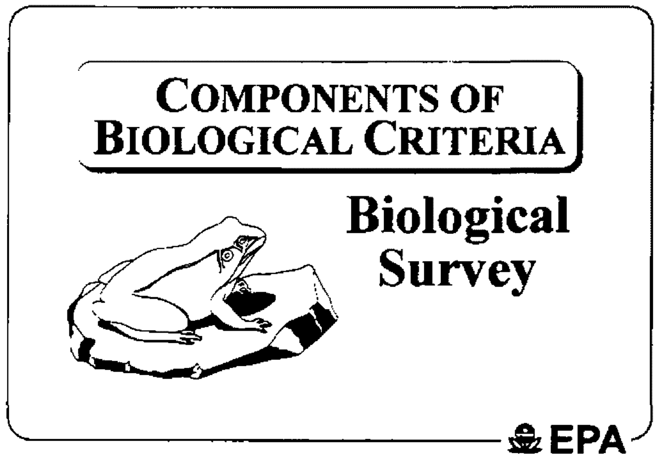
Slide 36: Aerial Photo



— COMPONENTS OF BIOLOGICAL CRITERIA: 2. BIOLOGICAL SURVEY —

Biological surveys are used to conduct the investigations of subject waterbodies to determine whether criteria are met.

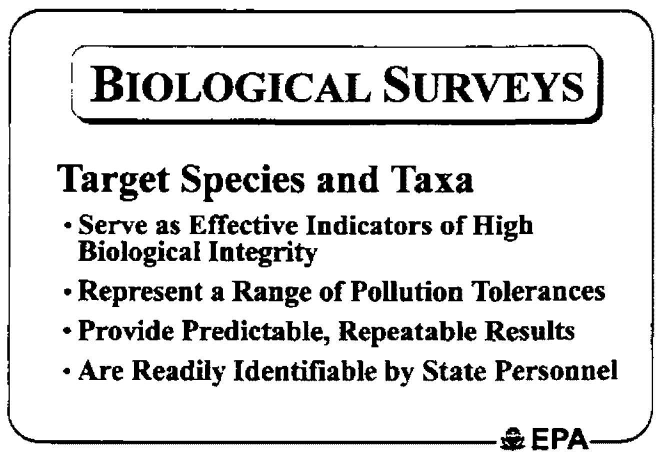
Slide 37: Component 2



Survey design must be scientifically rigorous and biologically relevant to detect problems of regulatory concern.

Selecting community components.

Slide 38: Bioassessment Components

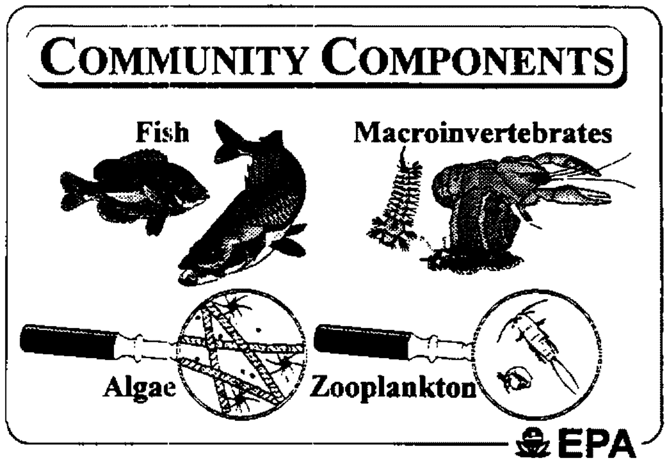


The most useful measures of biological integrity have been

- number of species,
- degree of dominance, and
- organism size reduction.

Components chosen will vary depending on the type of ecosystem.

Slide 39: Fish



Components should be measured in a way that best describes the structure and function of aquatic communities.

Structural metrics describe the composition of a community.

Functional metrics describe the ecological processes of the community.

Slide 40: Metrics Types

METRICS TYPES

Structural:

Community Composition (Species Number, Abundance, and Ratios of Tolerant and Intolerant Species)

Functional:

Describe Processes (Community Photosynthesis)

EPA

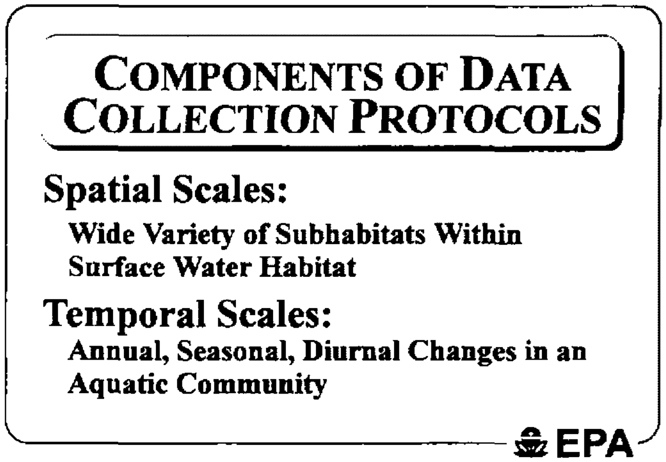
[CLASS EXERCISE]

Careful design and statistical protocols are required to reduce sampling error and to evaluate natural variability.

Data collection protocols should incorporate:

- spatial scales and
- temporal scales.

Slide 41: Protocol Scales



Spatial scales refer to the wide variety of subhabitats that exist within any surface water habitat.

Temporal scales refer to aquatic community changes that occur over time and to life-cycle changes in organism behavior.

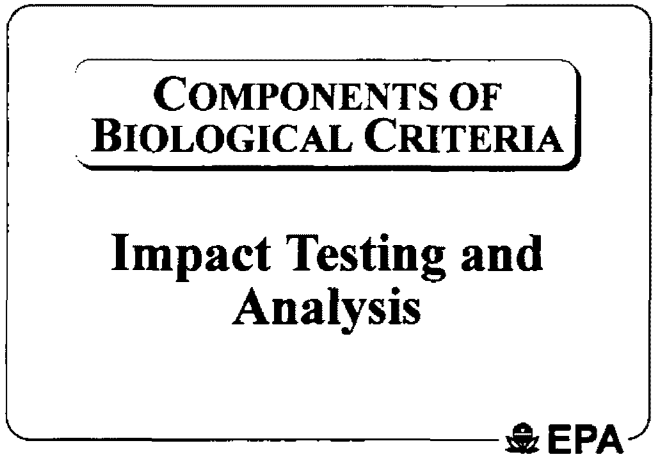
Rapid bioassessment protocols use standardized techniques to gather data quickly.

Slide 42: Stream Sampling

— COMPONENTS OF BIOLOGICAL CRITERIA: 3. IMPACT TESTING AND ANALYSIS —

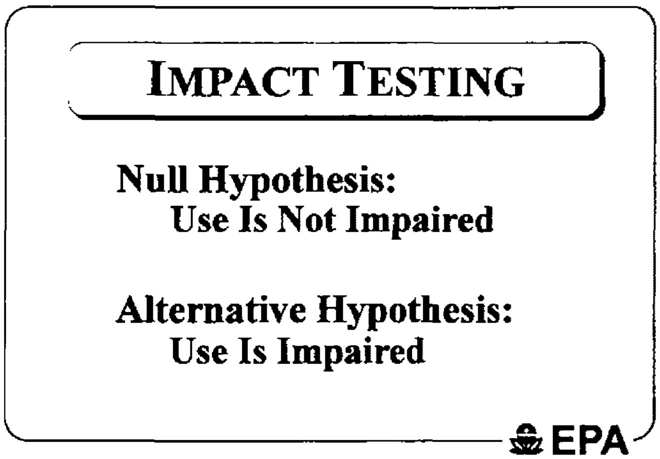
The final component of biological criteria development is impact testing and analysis.

Slide 43: Component 3



Biological criteria are used to test hypotheses about the degree of biological impairment of surface waters.

Slide 44: Impact Testing



Data are used to evaluate whether or not characteristics of biota are significantly different from established criteria. Hypothesis testing is an established approach for doing this. Analysis of variance is another approach used by some States, but not described here.

Use impaired.

Slide 45: Outcomes-1

OUTCOMES

1. **The Use Is Impaired**

   When Survey Design and Data Analysis Are Sensitive Enough To Detect Differences of Regulatory Importance, and Significant Differences Are Detected.

EPA

Criteria achieved.

Slide 46: Outcomes-2

OUTCOMES

2. **The Biological Criteria Are Met**

   When Survey Design and Data Analysis Are Sensitive Enough To Detect Differences of Regulatory Importance, but No Differences Are Found.

EPA

Outcome indeterminate.

Slide 47: Outcomes-3

OUTCOMES

3. The Outcome Is Indeterminate

When Survey Design and Data Analysis Are Not Sensitive Enough To Detect Differences of Regulatory Importance, and No Differences Are Detected.

EPA

Impairment of a designated use requires a diagnosis of the probable cause.

Slide 48: Diagnostic Questions

DIAGNOSTIC QUESTIONS

- **What Are the Obvious Causes of Impairment?**
- **If No Obvious Causes Are Apparent, What Possible Causes Do the Biological Data Suggest?**

EPA

[VIDEO: Development of Biological Criteria]

Future Directions.

Slide 49:

FUTURE DIRECTIONS

- Lakes and Reservoirs
- Estuaries and Coastal Marine Waters
- Wetlands
- Large Rivers
- Coral Reefs

EPA

Slide 50:

FUTURE DIRECTIONS

New Initiative
Technical Assistance
Pilot Project

EPA

Note: Slides 51 through 75 do not appear in the Participant Manual.

Summary.

Slide 76: Applications

REVIEW QUESTIONS

1. True or False. Biological integrity is one principal objective of the Clean Water Act.

2. Where numeric criteria for the 126 priority pollutants are not available, section 303(c)(2)(B) requires States to adopt criteria based on what?

   a. Single bioassays
   b. Biological assessment and monitoring methods
   c. Literature reviews

3. The condition of the aquatic community inhabiting the unimpaired waterbodies of a specified type, as measured by community structure and function, is known as:

   a. chemical integrity
   b. physical integrity
   c. biological integrity

4. True or False. Water quality programs in most States currently use comprehensive biological criteria to protect biological integrity.

5. True or False. EPA's goal is to develop national biological criteria for each waterbody type.

6. True or False. When developing biological criteria, any reference site may be chosen as long as standard sampling protocols are applied.

7. Site-specific reference conditions are best applied to:

   a. lakes and ponds
   b. small rivers and streams
   c. wetlands

8. Which is not a difficult situation for application of site-specific reference conditions?

    a. diffuse nonpoint source pollution throughout a waterbody
    b. extensive channel or shoreline modifications
    c. multiple point source locations
    d. heavy point source contamination from one discrete release area

9. The two site-specific reference condition approaches are (circle the two that apply):

    a. near field-far field
    b. paired watersheds
    c. upstream-downstream
    d. ecoregions

10. True or False. The ecoregion maps have yet to be applied to State water quality programs.

11. True or False. Caution should be exercised when selecting minimally impacted sites for ecoregion reference conditions because many minimally impacted sites (e.g., spring-fed stream) are atypical of the region.

12. Which of the following are essential characteristics for species to be selected as community components for a bioassessment? (Circle all that apply.)

    a. Likely to live in unimpaired waters
    b. Previously not described by taxonomists
    c. Readily identified by trained State personnel
    d. Active during only part of the year

13. Types of metrics used in bioassessments include (circle all that apply):

    a. structural measures, such as number of species
    b. functional measures, such as plant productivity
    c. economic value, such as monetary benefits of navigation

14. True or False. The Index of Biotic Integrity (IBI) is the total number of fish species collected in a standard sample.

15. True or False. Biological criteria are designed to replace chemical and whole-effluent criteria within water quality standards.

TRAINING MODULE 12:
ECOLOGICAL RISK ASSESSMENT

MODULE SUMMARY:

This module will introduce basic principles and concepts of ecological risk assessment, as currently practiced under guidelines developed by EPA.

NOTE: *This module is intended to serve only as an introductory training session on principles of ecological risk assessment. Follow-up training and technical support will be required for most participants who will be directly involved in the development of water quality criteria. Additional technical advisory support is available through EPA.*

OVERALL OBJECTIVES:

To provide an understanding of the principles of ecological risk assessment, including quantitative as well as qualitative aspects. These principles provide a basis for understanding the development and use of ambient water quality criteria and other risk information used in developing and implementing standards.

MEASURABLE OBJECTIVES:

After completing this module, participants will be able to:

- Define ecological risk assessment.
- Identify the differences between human health risk assessments and ecological risk assessments.
- Understand the statutory and regulatory basis for conducting ecological risk assessments and the different types of such assessments that can be done.
- Understand the role of communication in the design and execution of ecological risk assessments.
- Identify the phases of an ecological risk assessment and discuss the objectives of each phase.
- Distinguish between an assessment endpoint and a measure of effect.
- Understand that a variety of methods to evaluate causal associations and to quantify risk in ecosystems are available.
- Understand the importance of characterizing and communicating the uncertainties associated with the use of these methods for each assessment.
- Apply aquatic life, sediment, and biological criteria in an ecological risk assessment, as well as determine when it is inappropriate to do so.

LOGISTICS:

Teaching Method: Lecture (with Slides); Class Exercise

Approximate Presentation Time: 1 hour, 10 minutes (Lecture--30 minutes; Group Exercise—30 minutes; Review Questions—10 minutes)

Basic Course Reference Manual Documents:

12 Framework for Ecological Risk Assessment. U.S. Environmental Protection Agency, Risk Assessment Forum. 1992.

Other Documents:

Calabrese, E. J., and L. A. Baldwin. 1993. *Performing Ecological Risk Assessments.* Lewis Publishers, Boca Raton, Florida.

Hoffman, D. J., B. A. Rattner, G. A. Burton, Jr., and J. Cairns, Jr. 1994. *Handbook of Ecotoxicology.* Lewis Publishers, Boca Raton, Florida.

Howell, D. J. 1994. *Ecology for Environmental Professionals.* Quorum Books, Westport, Connecticut.

Landis, W. G., J. S. Hughes, and M. A. Lewis (eds.). 1993. *Environmental Toxicology and Risk Assessment.* ASTM STP 1179. American Society for Testing and Materials, Philadelphia.

Landis, W. G., G. B. Matthews, R. A. Matthews, and Anne Sergeant. 1994. Application of multivariate techniques to endpoint determination, selection and evaluation in ecological risk assessment. *Environmental Toxicology and Chemistry* 13:1917-1927.

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USEPA. 1989. *Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish.* EPA/444/4-89-001. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 1993 and 1994. *A Review of Ecological Assessment Case Studies from a Risk Assessment Perspective.* Volume 1: EPA/630/R-92/005; Volume 2: EPA/630/R-94/003. U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, DC.

MODULE 12 - OUTLINE
ECOLOGICAL RISK ASSESSMENT

— INTRODUCTION —

This module presents a brief overview of ecological risk assessment. It ties in with several other modules that have been or will be presented.

Slide 1: Introduction.

MODULE OVERVIEW

- Define Ecological Risk Assessment
- Differentiate Ecological Risk Assessment from Human Health Risk Assessment
- Discuss Phases of an Ecological Risk Assessment
- Demonstrate How an Ecological Risk Assessment Is Conducted

EPA

Efforts are underway to develop appropriate methodologies for a risk-based approach to ecosystem protection.

Ecological risk assessment is a process used to evaluate the likelihood that adverse effects may occur or are occurring as a result of exposure to one or more stressor.

Slide 2: Definition.

DEFINITION OF ECOLOGICAL RISK ASSESSMENT

- Process to Evaluate the Likelihood of Adverse Ecological Effects from Exposure to Stressors
- Tool to Help Meet Management Goals

EPA

Ecological risk assessment can increase the probability of achieving a desired environmental result.

Ecological risk assessments provide a valuable addition to several environmental programs and statutory requirements.

Slide 3: Value of Ecological Risk Assessment.

VALUE OF ECOLOGICAL RISK ASSESSMENT

- Improve Use Attainability Analysis
- Aid in Interpretation and Use of Criteria
- Improve Watershed Protection

EPA

There are three key groups of players in ecological risk assessment.

Slide 4: The Players.

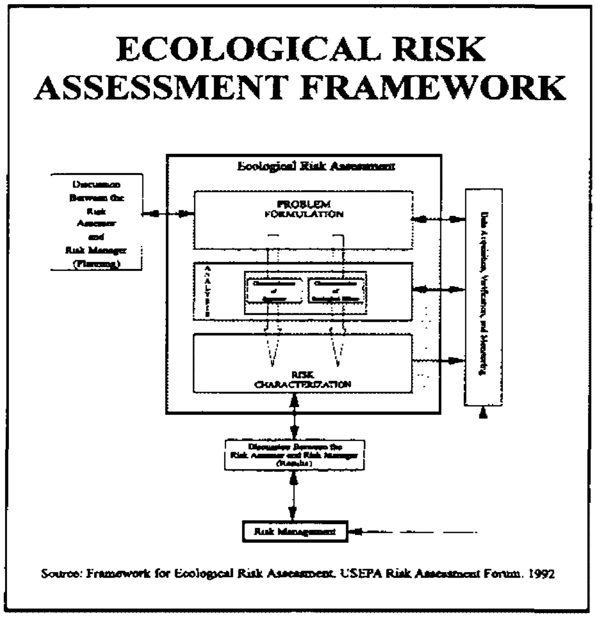
THE PLAYERS

- Risk Managers
- Risk Assessors
- Stakeholders

EPA

The framework developed by EPA provides guidance for conducting ecological risk assessments.

Display: Ecological Risk Assessment Framework.



There are three basic elements to the ecological risk assessment process.

Slide 5: Process.

THE PROCESS

1. Problem Formulation
2. Analysis
3. Risk Characterization

EPA

— PROBLEM FORMULATION —

The problem formulation phase of ecological risk assessment is when the people involved with water quality standards are most likely to be involved.

There are five general components of the problem formulation phase.

Slide 6: Problem Formulation.

THE PROCESS

1. Problem Formulation
   - **Articulate Management Goal**
   - **Assess Available Information**
   - **Develop Assessment Endpoints**
   - **Develop Conceptual Model**
   - **Develop Analysis Plan**

EPA

The first product of the problem formulation phase is a management goal.

Slide 7: Management Goal.

MANAGEMENT GOAL

Who Is Involved in the Assessment?
- Identify the Players

Why Do an Ecological Risk Assessment?
- Identify the Problem and Purpose
- Determine the Type of Assessment

EPA

The risk manager, in consultation with the stakeholders and risk assessors, examines the situation and identifies the need for a risk assessment.

The next part of the problem formulation phase involves the assessment of available relevant information.

Slide 8: Assessment of Available Information-1.

ASSESSMENT OF AVAILABLE INFORMATION

What Are the Problems?

- Characterize What Is at Risk
- Identify the Ecological Effects
- Describe the Sources and Characteristics of Stressors

EPA

Assessment of available information allows you to determine temporal and spatial limits of stressors.

Slide 9: Assessment of Available Information-2.

ASSESSMENT OF AVAILABLE INFORMATION

When do Problems Occur?
- Set Temporal Limits

Where do the Problems Occur?
- Set Spatial Limits

EPA

Available information is used to determine ecologically-based endpoints.

Assessment endpoints are explicit expressions of the actual environmental values that are to be protected.

Slide 10: Develop Assessment Endpoints.

DEVELOP ASSESSMENT ENDPOINTS

- Ecologically Relevent
- Susceptible to the Stressor
- Reflects Policy Goals and Societal Values

EPA

Assessment endpoints must be operationally-defined by a quantifiable attribute.

Slide 11: Attributes of Assessment Endpoints.

ASSESSMENT ENDPOINTS

- **Unambiguous Operational Definition**
  - **Ecological Component**
  - **Attribute of Component**
- **Subject to Prediction and Measurement**

EPA

Measure of effect is a measurable response to a stressor that is related to the valued characteristics selected.

Slide 12: Measures of Effect.

MEASURES OF EFFECT

- Measurable Ecological Characteristics
- Related to the Assessment Endpoint

EPA

Slide 13: Examples of Ecological Risk Assessment Endpoints.

EXAMPLE OF ECOLOGICAL RISK ASSESSMENT ENDPOINTS

Assessment Endpoint	Measure of Effect
Sport Fish Abundance	Fathead Minnow LC50
	Percent Mortality
	Species Abundance
	Spawning Behavior

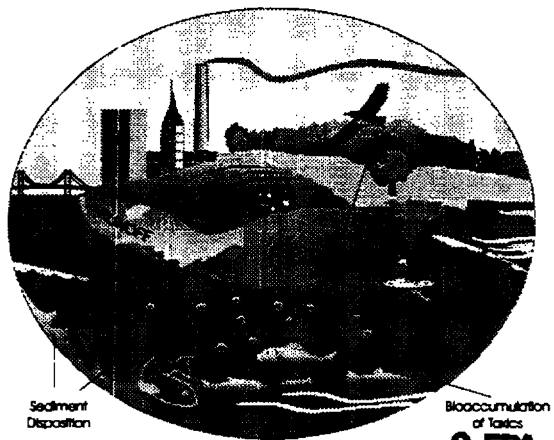
EPA

Conceptual models are used to establish the focus of the risk assessment.

One type of conceptual model graphically demonstrates the interactions in an ecosystem. This elementary level model wouldn't be appropriate in a risk assessment.

Slide 14: Conceptual Model-1.

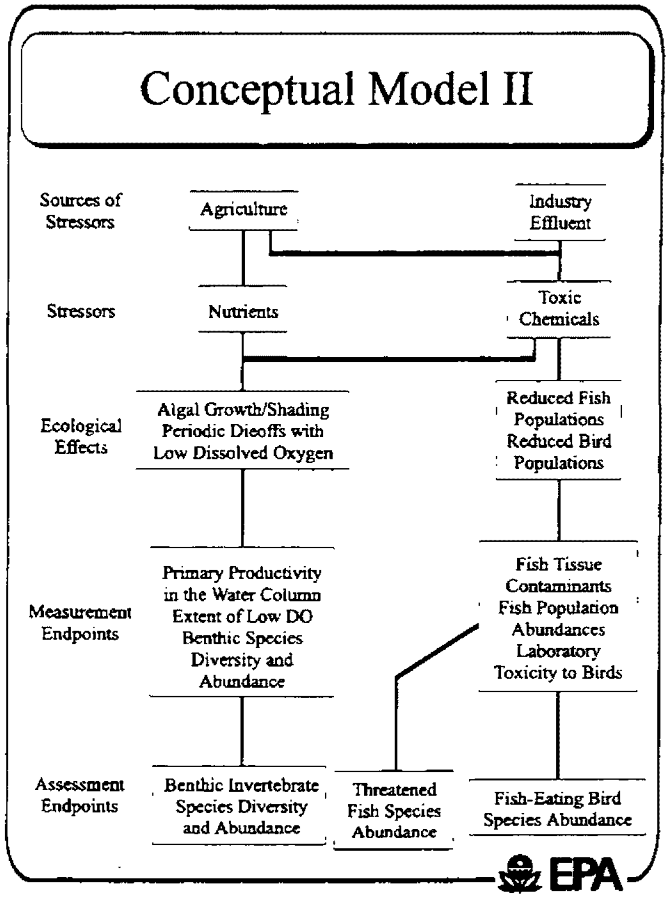
CONCEPTUAL MODEL I



EPA

A second type of conceptual model allows the risk assessor to identify possible exposure scenarios to link the stressors and effects to an appropriate endpoint.

Slide 15: Conceptual Model-2.



Once information is organized in a conceptual model, the risk assessor can develop a series of risk hypotheses.

The final step of the problem formulation phase is the development of an analysis plan.

Slide 16: Analysis plan.

ANALYSIS PLAN

How Will the Assessment be Conducted?

- Risk Hypotheses
- Objectives/Measures
- Data Quality and Quantity

EPA

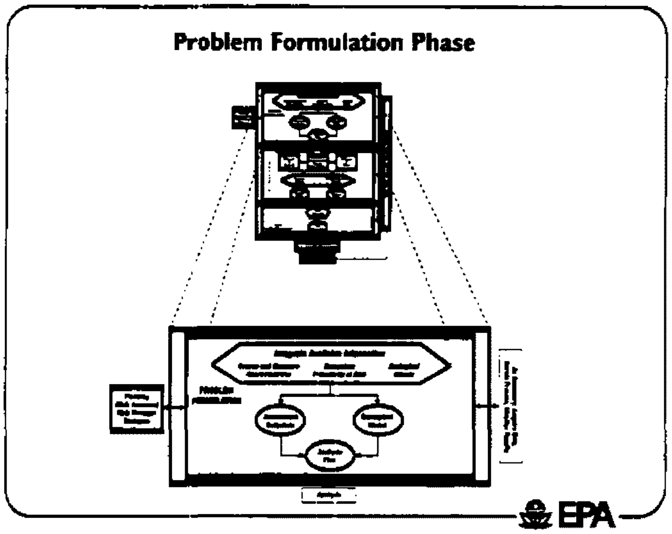
[CLASS EXERCISE]

— PROBLEM FORMULATION —

A successful problem formulation must have assessment endpoints that reflect the management goals and the ecosystem they represent; conceptual models that show key relationships; and an analysis plan.

Problem formulation requires dialogue between the risk assessors and risk managers.

Slide 17: Problem Formulation.



— MANAGEMENT GOALS —

When initiated by a stressor, characteristics of the stressor provide the foundation for development of conceptual models and assessment endpoints.

When initiated by an effect, the assessment endpoint is established first as the affected system.

Slide 18: Risk Assessment Initiation.

RISK ASSESSMENT INITIATION

What drives the risk assessment?

- **Source or stressor, e.g.,**
  - **toxic waste site**
  - **new chemical process or pesticide**
- **Observed effect**
  - **decline of endangered species**
- **Values of concern**
  - **protection or restoration of place (watershed, estuary, ecosystem)**
  - **protection or restoration of values**

Management goals must be agreed to by interested parties, clearly articulated and have a way to measure success.

Slide 19: Management Goals.

MANAGEMENT GOALS

- **Statutory goals (e.g., water quality standards, protection of endangered species)**
- **Goals agreed to by interested parties**
- **General goals must be translated as specific management objectives**

An assessment endpoint is an explicit expression of the environmental value that is to be protected.

An assessment endpoint must be susceptible to one or more stressors in the risk assessment.

Slide 20: Criteria for Assessment Endpoints.

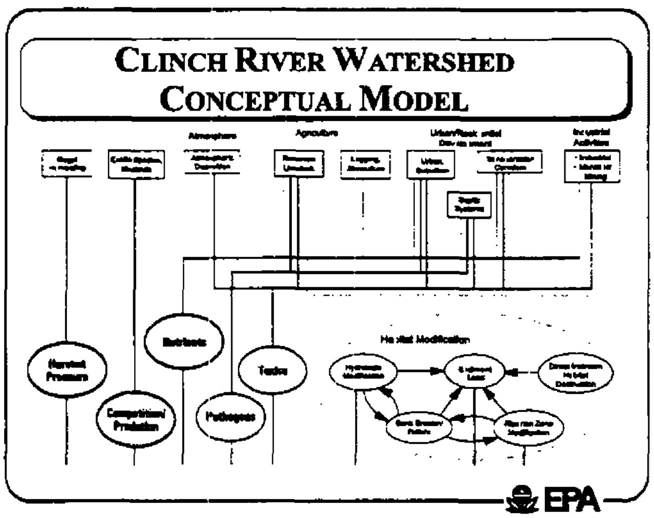
CRITERIA FOR ASSESSMENT ENDPOINTS

- **Ecological relevance**
- **Susceptibility to known or potential stressors**
- **Representation of management goals**

EPA

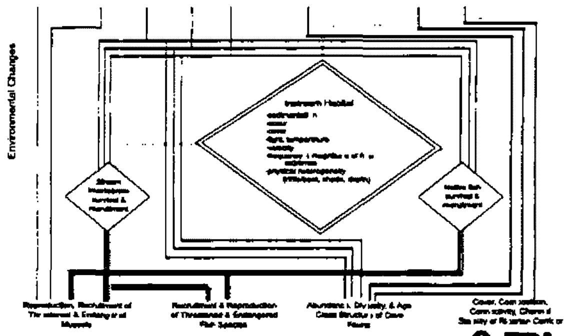
A conceptual model is a set of risk hypotheses that describe relationships between stressors, exposure, and assessment endpoint responses.

Slide 21: Example of Conceptual Model; Part 1.



Slide 22: Example of Conceptual Model; Part 2.

CLINCH RIVER WATERSHED CONCEPTUAL MODEL



EPA

Slide 23: Develop Analysis Plan.

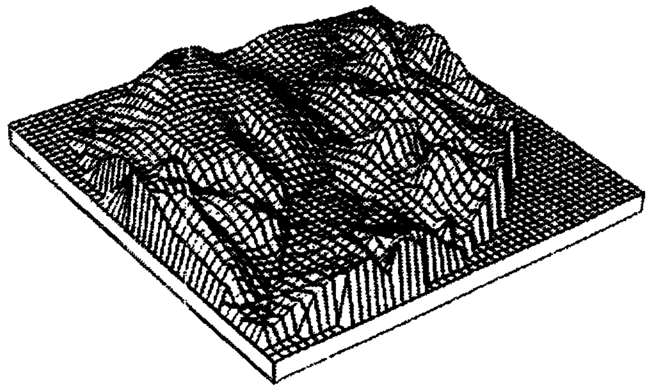
DEVELOP ANALYSIS PLAN

Develop Analysis Plan

- **How to Evaluate Risk Hypotheses**
- **Availability of Data**
- **Uncertainty**
- **Relate Analysis to Ultimate Decisions**

EPA

Slide 24: Topographic View of Watershed.

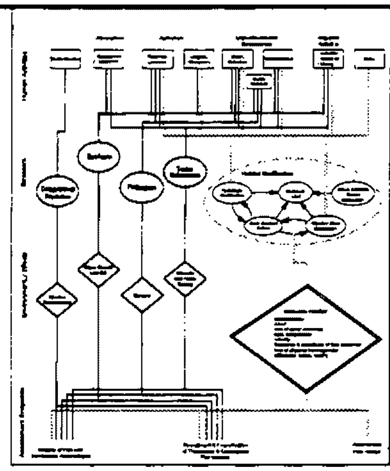


[CLASS EXERCISE - QUESTIONS]

Display: Dan River Watershed.

Display: Dan River Watershed Conceptual Model.

DAN RIVER WATERSHED CONCEPTUAL MODEL



— ANALYSIS —

The second step in the ecological risk assessment process is the analysis phase.

Slide 25: Analysis.

THE PROCESS

2. Analysis
   - Exposure Characterization
   - Ecological Effects Characterization

EPA

The purpose of characterizing exposure is to measure or predict spatial and temporal distribution of a stressor.

Slide 26: Exposure Characterization.

EXPOSURE CHARACTERIZATION

- Predict Spatial Distribution
- Predict Temporal Distribution

EPA

The purpose of characterizing ecological effects is to identify and qualify the adverse effects caused by a stressor and evaluate cause and effect relationships.

Slide 27: Ecological Effects Characterization.

ECOLOGICAL EFFECTS CHARACTERIZATION

- Identify and Quantify Adverse Effects
- Evaluate Cause-and-Effect Relationships

EPA

— RISK CHARACTERIZATION —

The final phase in an ecological risk assessment is risk characterization.

Slide 28: Risk Characterization.

THE PROCESS

3. Risk Characterization
   - Estimate Risks
   - Evaluate Uncertainties
   - Summarize Risk
   - Document Significance of Threat

EPA

There are many ways to estimate ecological risks, including the quotient method and stressor response curves.

Slide 29: Methods for Estimating Ecological Risks.

METHODS FOR ESTIMATING ECOLOGICAL RISKS

- Quotient Method
- Stressor-Response Curves

EPA

The quotient method is a common quantitative screening technique.

Slide 30: Quotient Method.

QUOTIENT METHOD

$$\text{Quotient Method} = \frac{\text{EEC}}{\text{WQC}}$$

EEC = Concentration of chemical estimated to occur in the environmental to which ecological components are likely to be exposed

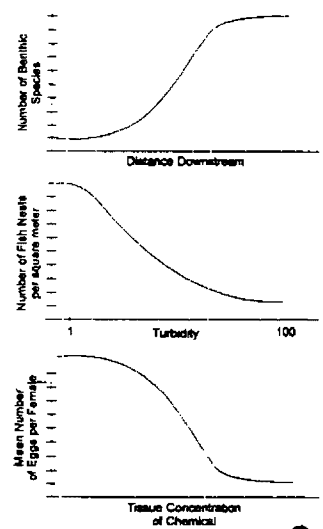
WQC = Estimated safe (no-effect) concentration such as the chemical's water quality criterion.

EPA

Stressor-response curves are developed considering frequency, timing, and duration of exposure are considered.

Slide 31: Stressor-Response Curve.

STRESSOR-RESPONSE PROFILES



EPA

Another important phase of risk characterization is evaluating the uncertainty.

Slide 32: Evaluating Uncertainty.

EVALUATING UNCERTAINTY

- Stochasticity
- Ignorance
- Human Error

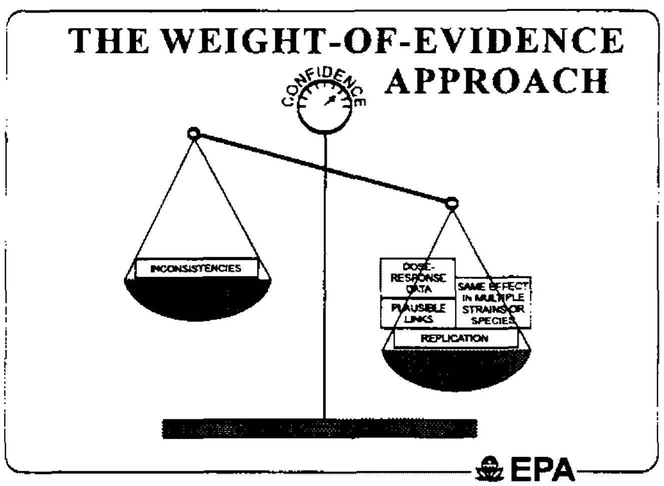
EPA

— FINAL PRODUCT —

The final product of an ecological risk assessment is a report summarizing the ecological risks and interpreting the ecological significance of the stressor.

The weight-of-evidence approach helps increase confidence in the conclusion of the assessment.

Slide 33: Weight-of-Evidence Approach.



After completing the ecological risk assessment, the risk manager will have to choose the appropriate options.

Slide 34: Options

OPTIONS

- No Action
- Take Action
- Modify an Action

EPA

REVIEW QUESTIONS

1. What is an ecological risk assessment?

   a. A study of the plants and animals in an ecosystem.
   b. An evaluation of the likelihood of adverse effects resulting from exposure to a stressor.
   c. The collection of data from a hazardous waste site.

2. Ecosystems can be affected by _______, as well as __________, types of stressors. Examples of some of these stressors are:

   a. Sediment
   b. Temperature
   c. pH
   d. Sunlight
   e. All of the above

3. To evaluate exposure of organisms to different types of stressors, what types of studies might be used?

4. True or False. Ecological risk assessments are less likely to produce quantitative estimates of risk than are human health risk assessments.

5. Fill in the blanks. The term _______ _________ means an explicit expression of the actual environmental values that are to be protected by management decisions that will be based on the ecological risk assessment. Data collected during the assessment should include measurable responses of this endpoint to the suspected stressor, and these responses are termed_______ ________. It is important to ______ the assessment endpoints and measures of effect by developing a ________ model before the ecological risk assessment begins.

6. Uncertainty is everywhere, but what does this mean in an ecological risk assessment?

   a. Somebody goofed somewhere.
   b. Nothing.
   c. Nature is inherently random.
   d. A lab test result always means the same thing as what is found in the field.
   e. a and c.

7. Give two examples of why we should identify the uncertainties associated with an ecological risk assessment to the risk manager.

8. What is the purpose of conducting an ecological risk assessment?

TRAINING MODULE 13:
PRINCIPLES OF RISK COMMUNICATION

MODULE SUMMARY:

This module presents basic risk communication principles. Participants apply those principles by developing a risk communication strategy for a hypothetical situation involving review of a water quality criterion.

OVERALL OBJECTIVES:

To raise awareness about how the public perceives risk, and to introduce participants to the basic principles of risk communication and the considerations involved in developing a risk communication strategy. To help participants be better prepared to handle risk communication situations that might arise during development and implementation of water quality standards.

MEASURABLE OBJECTIVES:

After completing this module, participants should be able to:
- Identify situations that might induce public outrage
- Demonstrate understanding of some basic principles of risk communication
- Demonstrate understanding of basic components of a risk communication strategy
- Apply basic principles of risk communication in developing a risk communication strategy

LOGISTICS:

Teaching Method: Lecture (with slides); Group exercises; Discussion.

Approximate Presentation Time: 2 hours (Opening Presentation—60 minutes; Walk-through of Case Study—10 minutes; Group Exercise—25 minutes; Wrap-up—25 minutes).

Other Documents:

A Citizen's Guide to Understanding Health Risks and Reducing Exposure. U.S. Environmental Protection Agency, Office of Policy, Planning, and Evaluation. 1990.

Resource Document for Workshop on Risk Communication. U.S. Environmental Protection Agency, Office of Policy, Planning, and Evaluation. 1989.

Covello, V.T., D.B. McCallum, and M.T. Pavlova. Effective Risk Communication: The Role and Responsibility of Government and Nongovernment Organizations. Plenum Press, New York. 1989.

NRC (National Research Council). Improving Risk Communication. National Academy Press, Washington, D.C. 1989.

MODULE 13 - OUTLINE
PRINCIPLES OF RISK COMMUNICATION

— INTRODUCTION —

Any situation that involves public health also has the potential to arouse public concern.

[PARTICIPANT EXPERIENCES]

— HAZARD VERSUS OUTRAGE —

The public perception of risk has been extensively studied in recent years.

Slide 1: Risk Equation

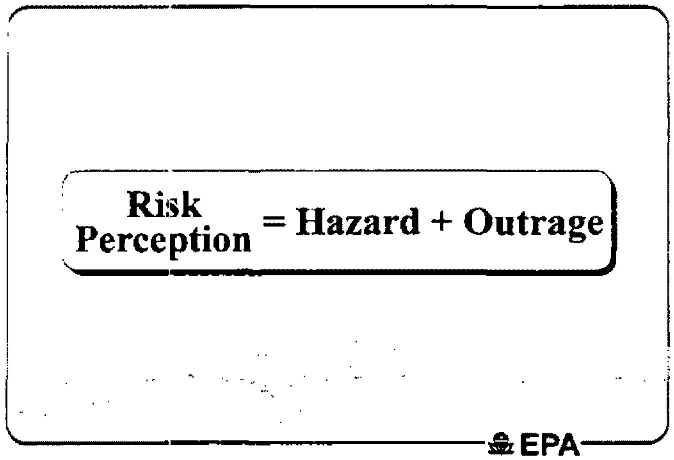
Risk = Hazard + Exposure

EPA

Hazard refers to the scientific component of risk perception.

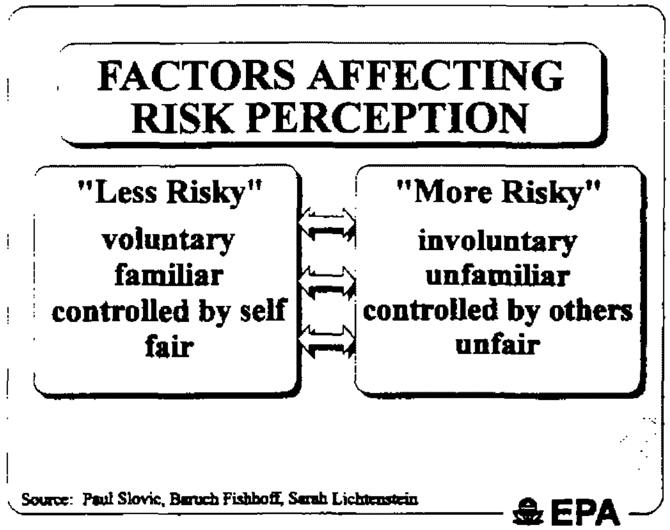
Outrage refers to the emotional component of risk perception.

Slide 2: Risk Perception

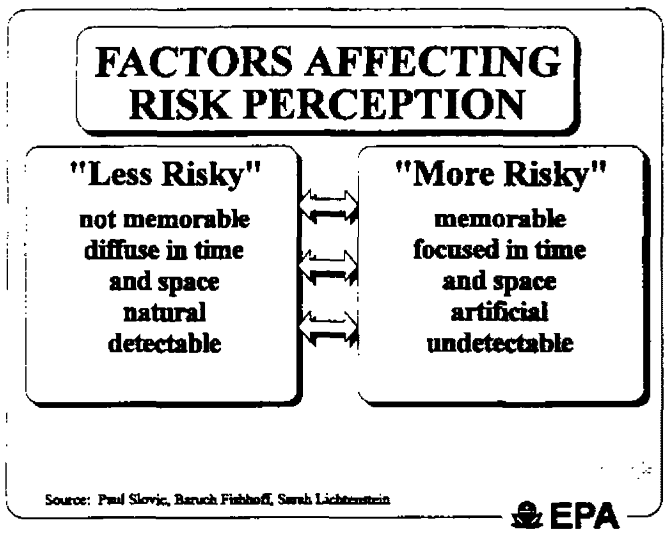


- Studies of risk communication have shown that there are several outrage factors.

Slide 3: Factors-1



Slide 4: Factors-2



[CLASS EXERCISES]

— THE SEVEN CARDINAL RULES OF RISK COMMUNICATION —

Rule 1: Accept and Involve the Public as a Legitimate Partner.

Slide 5: Rule 1

ACCEPT AND INVOLVE THE PUBLIC AS A LEGITIMATE PARTNER

- **The goal of risk communication is to produce an informed public that participates in developing solutions to the problem.**
- **Involve the public early in the process, before decisions have been made.**
- **Involve all parties that may have an interest or stake in the outcome.**

EPA

Rule 2: Plan Carefully, Evaluate Your Efforts, and Learn from Your Mistakes.

Slide 6: Rule 2-1

PLAN CAREFULLY, EVALUATE YOUR EFFORTS, AND LEARN FROM YOUR MISTAKES

- **Begin with clear, explicit risk communication objectives.**
- **Evaluate the risk information you have.**

EPA

Slide 7: Rule 2-2

PLAN CAREFULLY, EVALUATE YOUR EFFORTS, AND LEARN FROM YOUR MISTAKES

- **Classify your audience and target communication strategies to the different subgroups.**
- **Recruit spokespeople who are good at presentation and interaction.**

EPA

Rule 3: Listen to the Public's Specific Concerns.

Slide 8: Rule 3-1

LISTEN TO THE PUBLIC'S SPECIFIC CONCERNS

- **Try to put yourself in your audience's shoes.**
- **Don't assume you know what people know, think, feel, or want done about the risks.**
- **Take time to find out what people think.**

EPA

Slide 9: Rule 3-2

LISTEN TO THE PUBLIC'S SPECIFIC CONCERNS

- **Listen to all parties that have an interest or stake in the issue.**
- **Recognize and respect people's emotions.**
- **Legitimize people's concerns.**
- **Be calm.**

EPA

Listening is essential to building trust.

Slide 10: Active Listening-1

STEPS IN ACTIVE LISTENING

- **Listen for the main idea(s). Look for feelings. Pay attention to body language.**
- **Paraphrase the speaker's main ideas. Recognize the person's feelings. "I understand that . . ." "What you are saying is . . ." "Let me make sure I understand. You think . . ."**

EPA

Slide 11: Active Listening-2

STEPS IN ACTIVE LISTENING

- **Listen and look for confirmation of your understanding.**
- **If the speaker clarifies your understanding, paraphrase your new understanding.**

EPA

There are advantages of active (reflective) listening.

Slide 12: Advantages

BENEFITS OF ACTIVE LISTENING

- **Defuses strong emotion.**
- **Recognizes and legitimizes people's feelings and concerns.**
- **Helps ensure accurate communication.**
- **Avoids defensiveness.**
- **Helps you remain objective.**

EPA

Rule 4: Be Honest, Frank, and Open.

Slide 13: Rule 4

BE HONEST, FRANK, AND OPEN

- **If you don't know an answer or are uncertain, say so. Get back with an answer.**
- **Admit mistakes.**
- **Disclose risk information as soon as possible.**
- **Lean toward sharing more information, not less.**
- **Discuss data uncertainties, strengths, and weaknesses.**

EPA

Not acknowledging uncertainty is a sure way to lose trust and credibility.

Slide 14: Uncertainties-1

ACKNOWLEDGE AND DISCUSS DATA UNCERTAINTIES

- **Explain what the uncertainties are.**
- **Explain how the data were developed (e.g., explain the risk assessment process).**
- **Explain that science is never completely certain and that the data provide a better basis for decision and action than guesswork.**

EPA

Slide 15: Uncertainties-2

ACKNOWLEDGE AND DISCUSS DATA UNCERTAINTIES

- **If data are highly uncertain, state:**
  - **What is known.**
  - **What steps will be taken to get better data.**
  - **What will be done in the meantime to reduce or protect against the risk.**

EPA

Rule 5: Coordinate and Collaborate with Other Credible Sources.

Slide 16: Rule 5

COORDINATE AND COLLABORATE WITH OTHER CREDIBLE SOURCES

- **Build bridges with other organizations.**
- **Determine who is best able to answer questions about risk.**
- **Whenever possible, issue communications jointly with other trustworthy sources.**

EPA

Rule 6: Meet the Needs of the Media.

Slide 17: Rule 6-1

MEET THE NEEDS OF THE MEDIA

- **Be open with and accessible to reporters.**
- **Respect their needs and deadlines.**
- **Provide background information on complex risk issues.**
- **Follow up on stories with praise or criticism as warranted.**

EPA

Slide 18: Rule 6-2

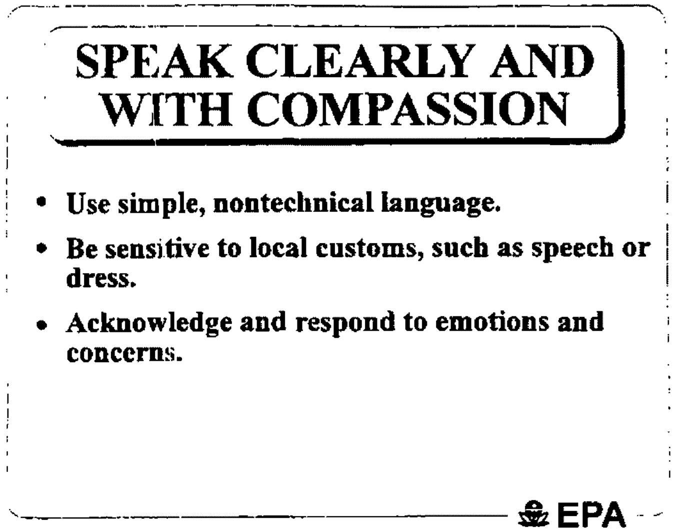
MEET THE NEEDS OF THE MEDIA

- **Try to establish long-term relationships of trust with specific editors and reporters.**
- **Ask the media what they need.**
- **Focus on the issues; avoid going off on tangents.**

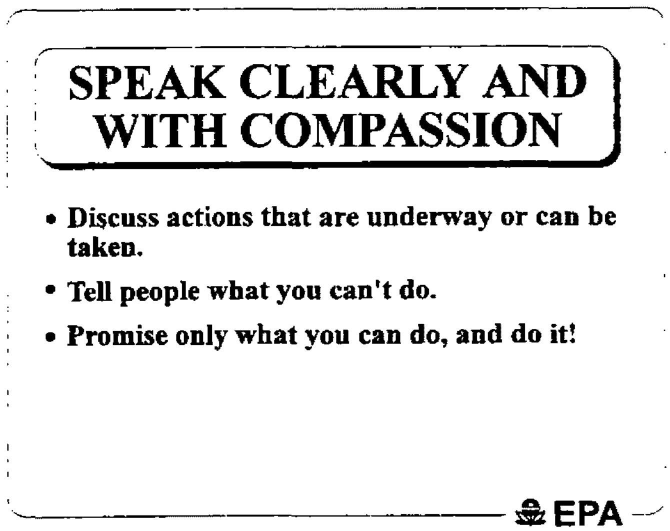
EPA

Rule 7: Speak Clearly and with Compassion.

Slide 19: Rule 7-1



Slide 20: Rule 7-2



— RISK COMMUNICATION STRATEGY EXERCISE —

Takes place in Newlandia, our 51st State.

DFS is found in the effluent of the arconalt industry.

Slide 21: DFS

DIFESTYLONIUM (DFS)

- **Found in many Newlandia surface waters.**
- **Manmade chemical discharged by the Arconalt industry.**
- **Regulated under Newlandia's WQS program.**

EPA

DFS has been classified as a B2 carcinogen.

Slide 22: DFS Properties

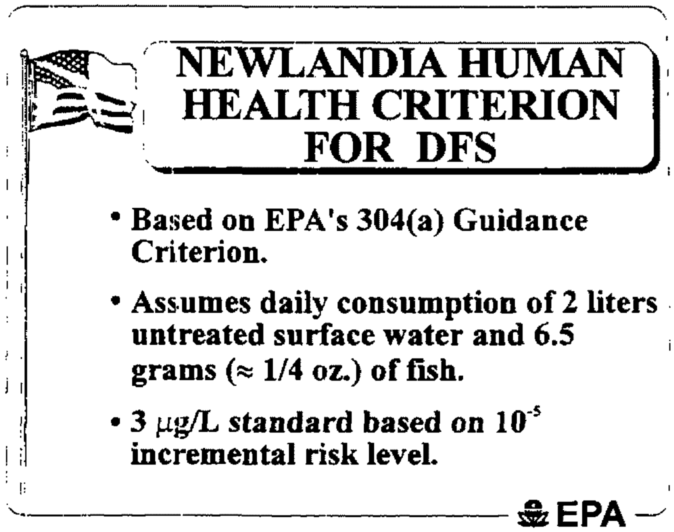
TOXICOLOGICAL PROPERTIES OF DFS

- **Immune system effects at relatively high levels of exposure.**
- **A carcinogen in animal studies by oral exposure at high doses.**
- **No human carcinogenicity data.**
- **Classified as a B2 carcinogen (probable human carcinogen).**

EPA

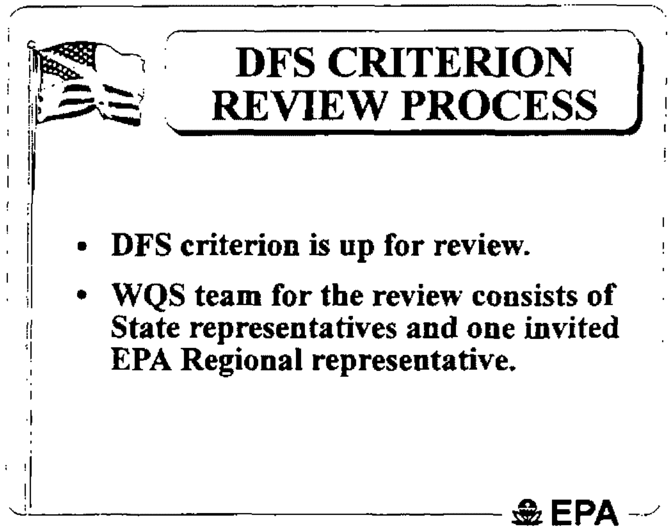
The State has essentially adopted the Federal ambient water quality criterion.

Slide 23: Human Health Criterion

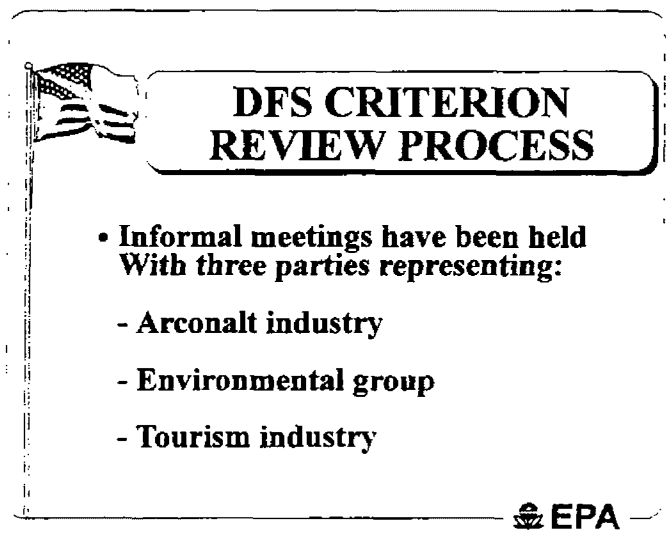


A team is reviewing the DFS criterion.

Slide 24: Review Process-1



Slide 25: Review Process-2



The Newlandia Arconait Industry Federation does not favor lowering the criterion.

Slide 26: NAIF-1

NEWLANDIA ARCONALT INDUSTRY FEDERATION (NAIF) POSITION

- **NAIF Provided These Data:**
  - **Industry compliance costs associated with current DFS standard (set at 10^{-5} risk level) = $350,000/cancer case avoided.**
  - **Industry compliance costs that would be associated with more stringent DFS standard (set at 10^{-6} risk level) = $3,500,000/cancer case avoided.**

EPA

Slide 27: NAIF-2

NEWLANDIA ARCONALT INDUSTRY FEDERATION (NAIF) POSITION

- **Does not want criterion lowered**
- **Further controls would impose undue financial burden**
- **20,000 jobs threatened**

EPA

The Newlandia Tourist Association is concerned with image.

Slide 28: NTA

NEWLANDIA TOURISM ASSOCIATION (NTA) POSITION

- **Concerned with image**
- **State must be perceived as having high quality surface water and a strong game fisheries resource**
- **Fears that lowering the DFS criterion may result in impairment of waterbodies and additional fish consumption advisories**

EPA

The Newlandia Sport Fishermen's Association is concerned about the health of its members.

Slide 29: Sport Fishermen-1

NEWLANDIA SPORT FISHERMEN'S ASSOCIATION (NSFA) POSITION

- **Over 100,000 members (5% of Newlandia population) - some are commercial fishermen**
- **Recent NSFA member survey indicates NSFA members and their families typically eat one-half pound of fish per week per person**

EPA

Slide 30: Sport Fishermen-2

NEWLANDIA SPORT FISHERMEN'S ASSOCIATION (NSFA) POSITION

- **Very concerned that the health of its members has been compromised**
- **Very concerned that the proposed standard will not be sufficiently protective**

EPA

[DEVELOPMENT OF RISK COMMUNICATION STRATEGY]

TRAINING MODULE 15:
VARIANCES

MODULE SUMMARY:

This module provides an overview of the requirements for and uses of variances in the water quality standards and criteria programs.

OVERALL OBJECTIVES:

To provide a basic understanding of a variance, how variances are used and how they differ from use reclassification and site-specific criteria, and the limitations of variances.

MEASURABLE OBJECTIVES:

After completing this module, participants should be able to:

- Define a variance
- Identify three key points regarding variances
- List factors in the Water Quality Standards Regulation that can be used to support a variance
- Explain the differences between variances and use reclassification or site-specific criteria

LOGISTICS:

Teaching Method: Lecture (with slides).

Approximate Presentation Time: ½ hour (Lecture—20 minutes; Review Questions—10 minutes).

Basic Course Reference Manual Documents:

1 Clean Water Act: sections 301(b)(1); 402(a)(1).

4 Water Quality Standards Handbook, Second Edition, August 1994.
Chapter 5, Section 5.3: Variances from Water Quality Standards
Appendix A: Water Quality Standards Regulation (40 CFR 131.10(g); 131.13).

5 U.S. EPA's Environmental Appeals Board. NPDES Appeal 88-5. In the Matter of Star-Kist Caribe, Inc. Decided May 26, 1992.

6 EPA's Proposed Combined Sewer Overflow Control Policy. April 19, 1994.

Other Documents:

National Assessment of State Variance Procedures. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Criteria and Standards Division. November 1990.

MODULE 15 - OUTLINE
VARIANCES

— DEFINITION AND KEY COMPONENTS —

A variance should be used only when there is uncertainty as to whether a standard can be attained or when compliance is deemed attainable in the foreseeable future.

Slide 1: Definition

VARIANCE

A Short-Term Modification from Meeting Applicable Water Quality Standards

EPA

There are several key points to remember regarding variances.

Slide 2: Key Points

KEY POINTS OF VARIANCES

1. **Temporary Exemptions**
2. **Provide Alternative to Downgrading**
3. **Determine Permit Limits For Discharger**
4. **Established by States – Approved/Disapproved by EPA**
5. **Subject to Public Review**
6. **Incorporated into Water Quality Standards**
7. **Analyses Similar to UAAs**

EPA

— REGULATORY OVERVIEW AND HISTORY —

40 CFR 131.13 — States may include variances in their water quality standards and policies.

The variance policy originated in an Office of General Counsel (OGC) opinion, number 58, dated March 29, 1977.

— FACTORS FOR JUSTIFYING VARIANCES —

40 CFR 131.10(g) — Factors to be used for justifying variances.

Slide 3: Factors

FACTORS JUSTIFYING VARIANCES

1. **Naturally Occurring Pollution**
2. **Natural Low-Flow Conditions**
3. **Irretrievable Human-Caused Conditions**
4. **Hydrologic Modifications**
5. **Physical Conditions**
6. **Substantial and Widespread Economic and Social Impact**

EPA

EPA reviews and approves both the overall State variance policy and individual variances.

Variances differ from use reclassification, site-specific criteria, and water quality standards compliance schedules.

Slide 4: Differences-1

DIFFERENCES

VARIANCES
- **Short-Term Criteria Change**
- **Basic WQS Remain**

SITE-SPECIFIC CRITERIA
- **Permanent Change in WQS**
- **Designated Use Unchanged**

USE RECLASSIFICATION
- **Permanent Change in WQS**
- **Criteria Also Change**

WQS COMPLIANCE SCHEDULES
- **In Permit or BMP to Meet WQS**
- **No Subsequent Change in WQS**

EPA

Variances determine the permit limits for discharges.

— BENEFITS AND PROBLEMS —

Variances from standards should be used only as a temporary measure and only where justified.

Benefits.

Slide 5: Intended Benefits

BENEFITS

A Variance Allows Time to Evaluate Attainability of Standards Prior to Forcing Expensive Controls

EPA

Problems.

Slide 6: Problems

A national program assessment conducted by EPA in 1990 indicated that States do not routinely grant variances.

Some States provide a generic exception for nonpoint sources of pollution.

— SUMMARY —

Slide 7: Summary 1

VARIANCES

- Short-Term Modifications from Meeting Water Quality Criteria
- Discharger-Specific for Same Factors Used for Downgrading

EPA

Slide 8: Summary 2

KEY POINTS

- Temporary
- Alternative to Downgrading
- Allow Legal Permit Limit
- State Adopted - EPA Review
- Require Public Review
- Legally Enforceable

EPA

REVIEW QUESTIONS

1. True or False. Water quality standards variances are specifically provided for in the Clean Water Act.

2. Variances are provided for in section ___ of the Water Quality Standards Regulation.

   a. 131.13
   b. 131.10(g)
   c. #58

3. Which of the following is not a viable basis for granting a discharger a variance?

   a. naturally occurring pollution
   b. natural low-flow conditions
   c. existing hydrologic modifications
   d. economic impact to the discharger

4. Which of the following is not true of a variance?

   a. A variance is a short-term modification to the applicable water quality standards for a discharger.

   b. Adoption of a variance is one way to change basic water quality standards.

   c. Variances provide a means to temporarily change water quality standards.

5. True or False. EPA has the authority to review each individual variance.

TRAINING MODULE 16:
ECONOMIC CONSIDERATIONS

MODULE SUMMARY:

This module provides a basic understanding of when it is appropriate to consider economic conditions within the water quality standards process and how to evaluate claims of adverse economic impacts.

OVERALL OBJECTIVES:

To provide a basic understanding of what information is needed from both private and public entities to demonstrate that water quality standards requirements will result in substantial and widespread social and economic impacts.

MEASURABLE OBJECTIVES:

After completing this module, participants will be able to:

- Identify the components of the water quality standards process that allow for the consideration of economic factors
- Define substantial and widespread social and economic impacts to dischargers and communities
- Demonstrate usage of four types of financial tests to determine a private entity's financial health and ability to pay for pollution controls
- Evaluate the social costs to the surrounding community when an entity complies with pollution reduction requirements
- Identify information that public entities must present to demonstrate that a publicly financed project will cause substantial and widespread economic impact

LOGISTICS:

Teaching Method: Lecture; Slides; Case study [Video — optional].

Approximate Presentation Time: (1½ hours; Lecture — 35 minutes; Case Study — 45 minutes; [Optional Video — 15 minutes]; Review Questions — 10 minutes.)

Basic Course Reference Manual Documents:

4 Water Quality Standards Handbook, Second Edition, August 1994.
Appendix A: Water Quality Standards Regulation: 40 CFR 131.10; 131.12; and 131.13.
Appendix M: Interim Economic Guidance for Water Quality Standards — Workbook

MODULE 16 - OUTLINE
ECONOMIC CONSIDERATIONS

— INTRODUCTION —

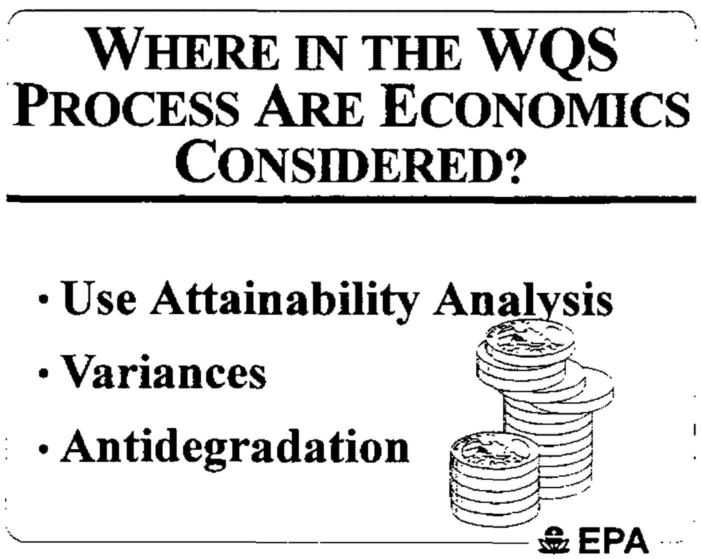
[OPTIONAL VIDEO: ECONOMIC CONSIDERATIONS IN WATER QUALITY STANDARDS]

— WATER QUALITY STANDARDS PROCESS OVERVIEW —

Federal regulations are not intended to result in water quality standards that are so stringent that compliance would cause severe economic impacts on communities.

To demonstrate economic hardship, applicants must demonstrate substantial and widespread economic and social impacts.

Slide 1: Where Considered



Use Attainability Analyses are assessments of the environmental and economic factors affecting the attainment of a designated use.

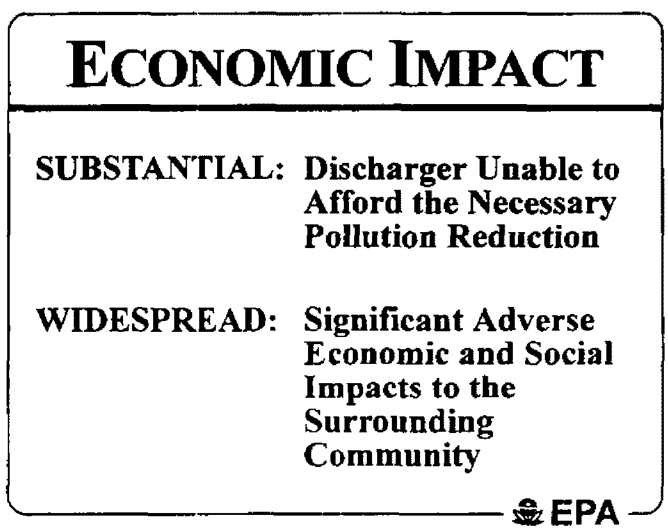
40 CFR 131.13 - Variances may be granted to a polluting entity only if economic hardship can be demonstrated.

40 CFR 131.12 - Economic considerations are also part of the antidegradation policy. States may lower water quality only if it is necessary to accommodate important economic or social development.

Wastewater dischargers must consider all alternatives.

To demonstrate economic hardship two conditions must be demonstrated.

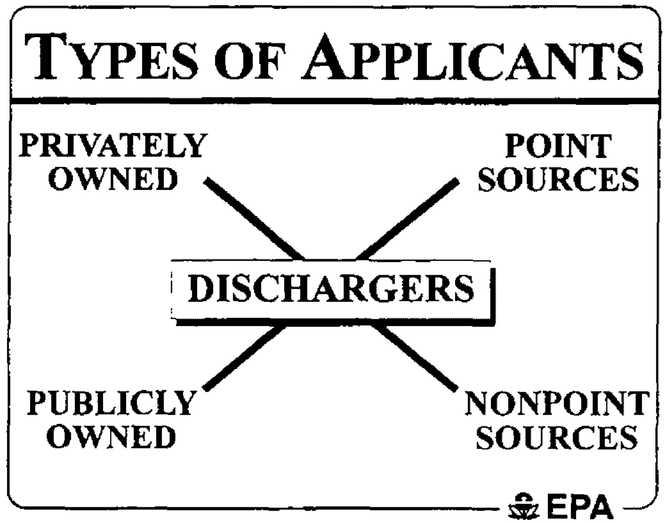
Slide 2: Economic Impact



— REVIEW OF SPECIFIC APPLICATIONS —

The distinction between public and private entities is critical in an economic impact analysis.

Slide 3: Applicant Types



Publicly owned entities include

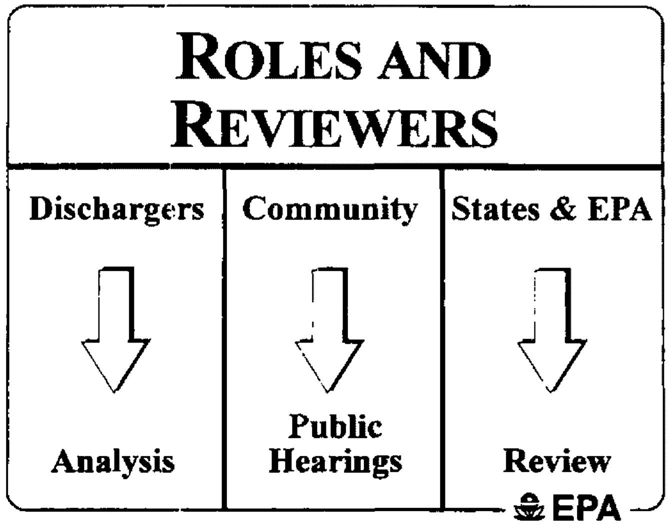
- publicly owned sewage treatment works;
- regional sewage authorities;
- roads; and
- other municipal infrastructure.

Privately owned entities include

- manufacturing facilities;
- agricultural operations;
- shopping centers and other commercial developments;
- residential developments; and
- recreational developments.

States, dischargers, and the general public take part in the development and implementation of water quality standards.

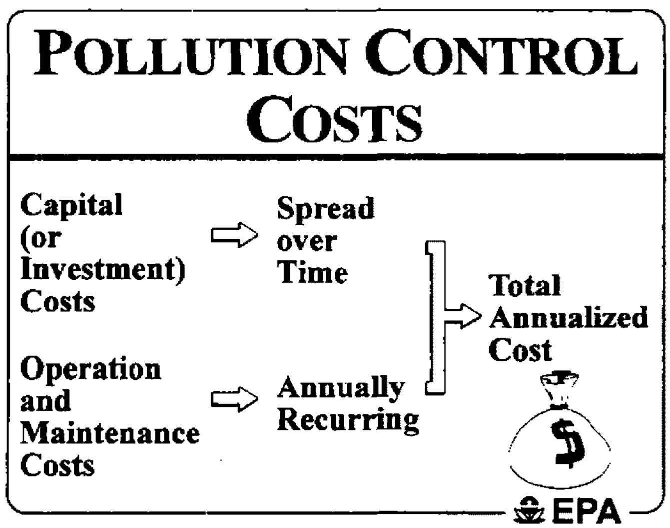
Slide 4: Roles and Reviewers



— SUBSTANTIAL IMPACTS —

Financial analysis requires calculation of project costs on an annual basis.

Slide 5: Pollution Control Costs



— PUBLIC ENTITIES —

To determine if a community can afford a project, two indicators are considered jointly.

Slide 6: Affordability

AFFORDABILITY FOR COMMUNITIES

- **MUNICIPAL AFFORDABILITY SCREENER**
  Ability to Pay, by Household
- **SECONDARY AFFORDABILITY**
  Community Assessment Indicators

EPA

The Municipal Affordability Screener answers the question: Can community households afford to pay the total annual pollution control costs?

Slide 7: Affordability Screener

MUNICIPAL AFFORDABILITY SCREENER

$$\frac{\textbf{Average Annualized Cost per Household}}{\textbf{Median Household Income}}$$

Used to Evaluate Expected Impacts to Households

Little Impact	Mid-Range Impact	Large Impact
< 0.8%	0.8% - 1.5%	≥1.5%

EPA

[CLASS EXERCISE]

The Secondary Affordability Test incorporates other factors that affect whether or not a community can afford to meet water quality standards.

Slide 8: Secondary Affordability

SECONDARY AFFORDABILITY TESTS

- **Debt Indicators (2 measures)**
- **Socioeconomic Indicators (2 measures)**
- **Financial Management Indicators (2 measures)**

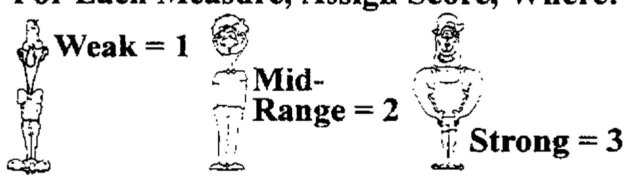
EPA

For each measure, a score of 1, 2, or 3 is assigned.

Slide 9: Assessment

SECONDARY AFFORDABILITY TEST METHOD OF ASSESSMENT

For Each Measure, Assign Score, Where:



Cumulative Secondary Affordability Score Equals the Weighted Average of These Scores.

EPA

Bond rating.

Slide 10: Bond Rating

SECONDARY AFFORDABILITY TEST DEBT INDICATORS

Measure 1: Bond Rating

Measures of Credit Worthiness of a Community

Source of Rating	Weak	Mid-Range	Strong
S&P	below BBB	BBB	above BBB
Moody's	below Baa	Baa	above Baa

EPA

Net debt relative to market value of taxable property.

Slide 11: Net Debt Ratio

SECONDARY AFFORDABILITY TEST DEBT INDICATORS

Measure 2: $\dfrac{\textbf{Overall Net Debt}}{\textbf{Market Value of Taxable Property}}$

Measures Debt Burden on Residents within the Community

Weak	Mid-Range	Strong
>5%	2% - 5%	<2%

EPA

Unemployment rate.

Slide 12: Unemployment Rate

SECONDARY AFFORDABILITY TEST SOCIOECONOMIC INDICATORS

Measure 1: Unemployment Rate

Measures the General Economic Health of the Community

Weak	Mid-Range	Strong
Above State Average	State Average	Below State Average

EPA

Median household income.

Slide 13: Median Household Income

SECONDARY AFFORDABILITY TEST SOCIOECONOMIC INDICATORS

Measure 2: Median Household Income

Provides Overall Indication of Community Earning Capacity

Weak	Mid-Range	Strong
Below State Average	State Average	Above State Average

EPA

Property tax revenue to market value of taxable property.

Slide 14: Tax Revenue Ratio.

SECONDARY AFFORDABILITY TEST
FINANCIAL MANAGEMENT INDICATORS

Measure 1: $\frac{\text{Property Tax Revenue}}{\text{Full Market Value of Taxable Property}}$

Measures Funding Capacity Available To Support Dept Based on Community's Wealth

Weak	Mid-Range	Strong
>4%	2% - 4%	<2%

EPA

Property tax collection rate.

Slide 15: Collection Rate.

SECONDARY AFFORDABILITY TEST
FINANCIAL MANAGEMENT INDICATORS

Measure 2: Property Tax Collection Rate

Measures How Well the Local Government Is Administrated

Weak	Mid-Range	Strong
<94%	94% - 98%	>98%

EPA

When calculating the Cumulative Secondary Affordability Score, all six measures are given equal weight.

Slide 16: Cumulative Assessment

CUMULATIVE SECONDARY AFFORDABILITY TEST ASSESSMENT

Average the Scores of All Measures

Weak	Mid-Range	Strong
<1.5	1.5 - 2.5	>2.5

For Example: 1 + 2 + 1 + 3 + 2 + 3 = 12
12/6 = 2

Community Falls within Mid-Range

EPA

The combination of the Secondary Assessment Score and the Municipal Affordability Screener indicates the community's ability to pay for proposed pollution control.

Slide 17: Matrix

ASSESSMENT OF SUBSTANTIAL IMPACTS MATRIX

Secondary Assessment Score	Municipal Affordability Screener		
	<0.8%	0.8 - 1.5%	>1.5%
<1.5	?	✖	✖
1.5 - 2.5	✔	?	✖
>2.5	✔	✔	?

? = Questionable affordability
✔ = Community can afford the pollution control
✖ = Community cannot afford the pollution control

EPA

— PRIVATE ENTITIES —

Four financial tests are commonly used to measure different aspects of a private entity's financial health.

Slide 18: Private Entities Tests

TESTS TO MEASURE ECONOMIC IMPACTS: PRIVATE ENTITIES

LIQUIDITY - **How Easily an Entity Can Pay Its Short-Term Bills**

SOLVENCY - **How Easily an Entity Can Pay Its Fixed and Long-Term Bills**

LEVERAGE - **How Much Money the Entity Can Borrow**

EARNINGS - **How Much the Entity's Profitability Will Change with the Additional Pollution Control**

EPA

The combined results of the financial tests are intended to answer the question of whether or not the entity can afford to pay these costs.

Liquidity.

Slide 19: Liquidity

LIQUIDITY TEST

$$\text{CURRENT RATIO} = \frac{\textbf{Current Assets}}{\textbf{Current Liabilities}}$$

Should Be Greater Than 2

EPA

Solvency.

Slide 20: Solvency

SOLVENCY TEST

$$\text{BEAVER'S RATIO} = \frac{\textbf{Cash flow per Given Year}}{\textbf{Total Debt of the Entity}}$$

> 0.20 Indicates Entity Is Solvent
< 0.15 Indicates Entity May Go Bankrupt

EPA

Leverage.

Slide 21: Leverage

LEVERAGE TEST

$$\text{DEBT-TO-EQUITY RATIO} = \frac{\textbf{Amount Firm Has Borrowed (Debt)}}{\textbf{Amount of Stockholders' Capital (Equity)}}$$

The Larger the Ratio, the Less Likely That the Entity Will Be Able To Borrow Funds

EPA

Earnings.

Slide 22: Earnings

EARNINGS TEST

PRE-TAX EARNINGS − ANNUALIZED POLLUTION CONTROL COST

Compare Result with Entity's Revenues to Measure Post-Compliance Profit Rate

EPA

The results of the four tests should be considered jointly.

Ratios and tests should be compared over several years.

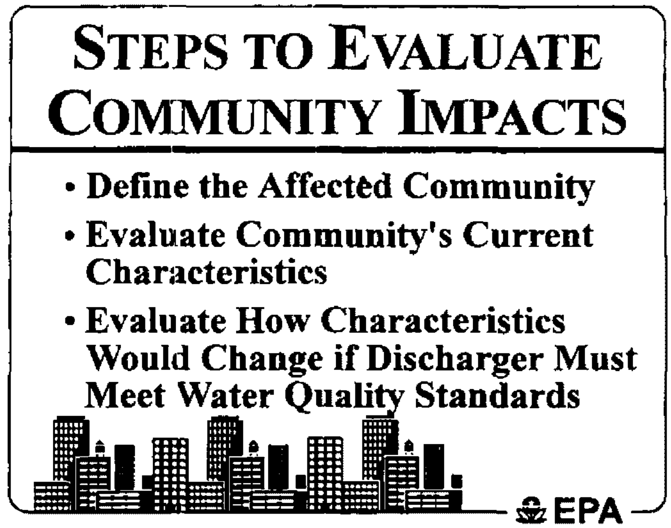
Financial ratios also should be compared against those of "healthy" entities.

The role the entity plays in a parent firm's operations should be considered.

— WIDESPREAD IMPACT —

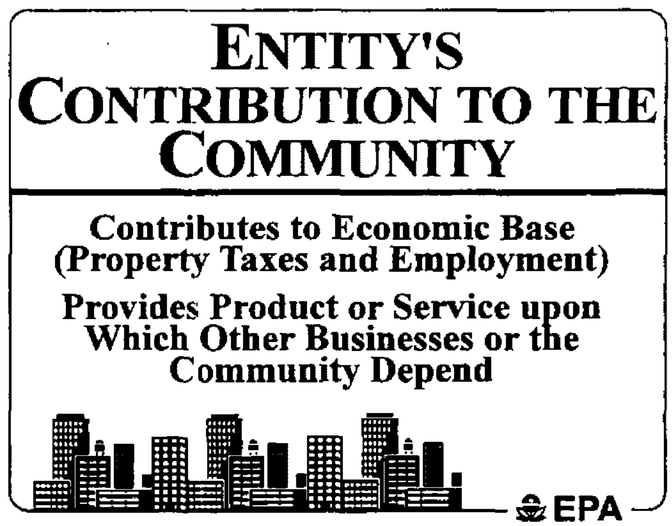
Three steps are involved in evaluating the social costs of pollution control requirements.

Slide 23: Soc:al Costs



The interdependence of the entity and the affected community is a major factor in demonstrating that impacts are not only substantial but also widespread.

Slide 24: Contr:bution



Factors that indicate the current health of the local economy may include information considered when calculating the Cumulative Secondary Affordability Score.

Slide 25: Socioeconomic Health

COMMUNITY'S CURRENT SOCIOECONOMIC HEALTH

- **Median Household Income**
- **Unemployment Rate**
- **Rate of Industrial Development**
- **Developing and Declining Industries**
- **Percent of Households Below Poverty Line**
- **Ability of Community to Carry More Debt**
- **Local & Regional Factors**

EPA

Other applicable information on the local and regional economy should also be reviewed:

- the annual rate of population change;
- current financial surplus as a percentage of total expenditures;
- the percentage of property taxes actually collected;
- property tax revenues as a percentage of the market value of real property;
- overall debt outstanding as a percentage of market value of real property;
- overall debt per capita; and
- the percentage of outstanding debt due within 5 years.

The analysis should consider how the community will be affected by development of the project.

Slide 26: Adverse Impacts

PROJECTED ADVERSE SOCIOECONOMIC IMPACTS OF PROJECT

- **Property Values**
- **Employment Rate**
- **Commercial Development Opportunities**
- **Tax Revenues**
- **Expenditure on Social Services**

EPA

One of the most serious impacts to communities is the loss of employment.

Affected communities may be faced with impaired development opportunities.

State-level impacts include

- loss of revenues; and
- increased expenditures.

[CLASS EXERCISE]

REVIEW QUESTIONS

1. True or False. Social and economic impacts may be grounds for a change in a designated use of a waterbody or for a variance from water quality standards if they would cause the discharger substantial hardship.

2. Which of the following are financial tests commonly used to measure different aspects of a private entity's financial health?

   a. solvency
   b. earnings
   c. liquidity
   d. leverage
   e. all of these (a-d) are financial tests
   f. a, c, and d only

3. True or False. A private entity can fail one of the financial tests yet still be financially strong and stable.

4. What steps must a private entity undertake in evaluating the social impacts of pollution control requirements on the surrounding community?

   a. define the affected community
   b. evaluate the current characteristics of the community
   c. evaluate how community characteristics would change if the private entity must meet water quality standards
   d. all of these (a-c) are steps

5. True or False. Whether or not a publicly financed project will impose substantial and widespread economic and social impacts on the community depends only on the ability of the public entity to finance the capital cost of the pollution control project.

6. In the case of a publicly funded project, when conducting an analysis of the affected community, which of the following factors should be considered?

   a. percentage of households below the poverty line
   b. median household income
   c. State, regional, local economic health
   d. rate of industrial development
   e. developing and declining industries
   f. a, b, and c only
   g. all of these (a-e) are factors

TRAINING MODULE 18:

THE WATER QUALITY STANDARDS SUBMITTAL AND APPROVAL PROCESS

MODULE SUMMARY:

This module presents an overview of the administrative process required for submission of State water quality standards. Further, it describes the process by which EPA reviews State- and Indian Tribe-adopted water quality standards, the types of approval possible, and Federal promulgation procedures.

OVERALL OBJECTIVES:

To present laws and regulations pertaining to State and Tribal submittal of water quality standards; requirements for State standards, including definitions; administrative procedures, such as conduct of public hearings; and the implications of a State's failure to submit standards. Additionally, to provide an understanding of the process by which EPA reviews water quality standards and the criteria used for approval.

MEASURABLE OBJECTIVES:

After completing this module, participants should be able to:

- Identify when States are required to review water quality standards
- Identify formal hearing requirements
- List State and Tribal submittal requirements for water quality standards
- Identify EPA's options if a State fails to submit standards
- Identify the components checked by EPA when reviewing a State's water quality standards
- Describe State actions required when EPA disapproves water quality standards
- Describe the process of Federal promulgation of standards
- Define conditional and partial approval of water quality standards

LOGISTICS:

Teaching Method: Lecture (with slides).

Approximate Presentation Time: 1 hour (Lecture—45 minutes; Review Questions—15 minutes).

Basic Course Reference Manual Documents:

1 Clean Water Act: sections 101(a)(2); 106; 303 (a)(3)(C); 303(c)(1); 303(c)(2)(A); 303(c)(3).

4 Water Quality Standards Handbook, Second Edition, August 1994.
Chapter 6: Procedures for Review and Revision of Water Quality Standards.
Appendix A: Water Quality Standards Regulation: 40 CFR 131.4; 131.5; 131.12; 131.13; 131.20; 131.21(c).

Other Documents:

40 CFR Part 130 (EPA's Water Quality Management Regulation).

40 CFR Part 25 (EPA's Public Participation Regulation).

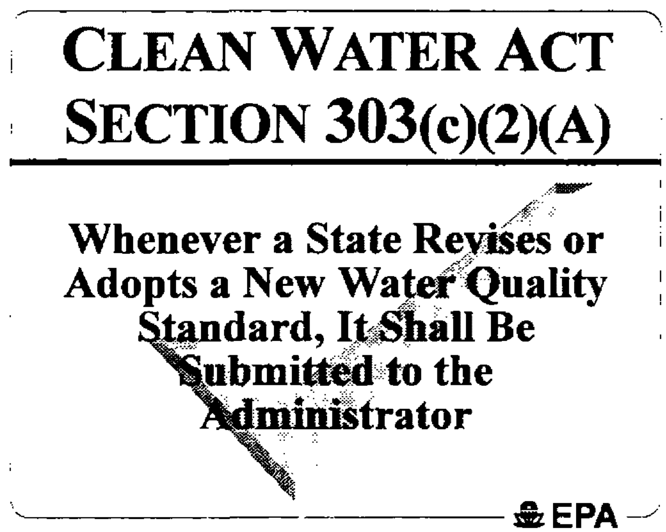
MODULE 18 - OUTLINE
THE WATER QUALITY STANDARDS SUBMITTAL AND APPROVAL PROCESS

— LEGAL/REGULATORY REQUIREMENTS —

Clean Water Act, section 303(c)(1)—States are required to review their water quality standards at least once every 3 years.

CWA, section 303(c)(2)(A).

Slide 1: CWA



CWA, section 303(c)(3)—EPA has the responsibility for reviewing State-adopted water quality standards.

40 CFR 131.6 and 131.20 —
Requirements for State submittal.

Slide 2: 40 CFR 131.20

40 CFR 131.20

STATES MUST:

- **Review Water Quality Standards at Least Once Every 3 Years**
- **Hold a Public Hearing**
- **Submit Review Results to the EPA Regional Administrator**

EPA

It is strongly recommended that the State meet with EPA regional staff.

— PUBLIC INVOLVEMENT —

A minimum of one public hearing must be held.

Hearings must be conducted in accordance with State law, 40 CFR Part 130 (EPA's Water Quality Management Regulation), and 40 CFR Part 25 (EPA's Public Participation Regulation).

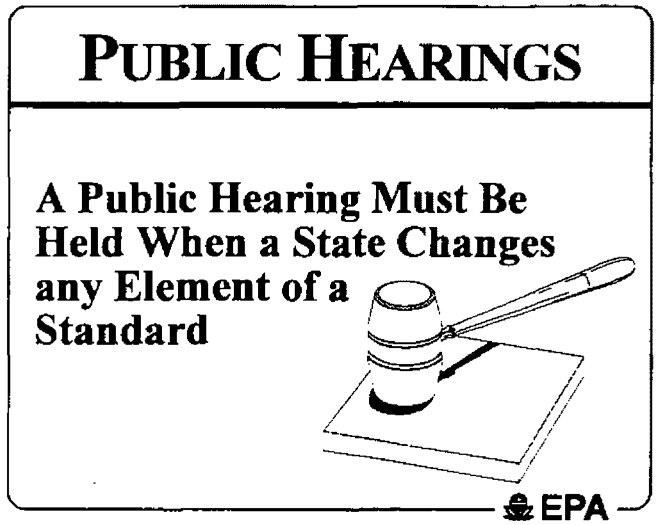
40 CFR 131.20(c) — Submittal to EPA.

Submittal must include

- Use Attainability Analysis (UAA) supporting analysis,
- site-specific criteria methodologies,
- general policies, and
- standard revisions.

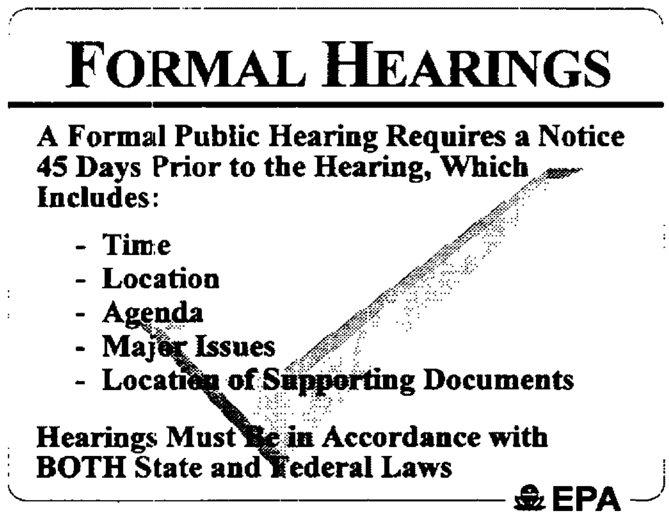
Public hearings are required by EPA regulations and the Clean Water Act.

Slide 3: Public Hearings



40 CFR Part 25 — EPA's Public Participation Regulation.

Slide 4: Formal Hearings



Each State agency must ensure that it is in compliance with all specific State requirements for rule-making hearings.

— SUBMISSION REQUIREMENTS —

40 CFR 131.6 — Elements of Submittal.

Slide 5: 40 CFR 131.6-1

SUBMITTAL ELEMENTS
40 CFR 131.6

1. Use Designations Consistent with the Act
2. Methods and Analyses Used
3. Water Quality Criteria to Protect Uses
4. Antidegradation Policy and Implementation Procedures

EPA

Slide 6: 40 CFR 131.6-2

SUBMITTAL ELEMENTS
40 CFR 131.6

5. Information to Support Uses Not Specified in Section 101(a)(2) of the Act
6. General State Policies Affecting Application and Implementation
7. Attorney General Certification
8. Information on Endangered Species Act

EPA

— CERTIFICATION —

EPA requires certification submitted by the State Attorney General to be assured that the standards under review legally apply in that State.

Certification is important because a State water quality standard remains in effect (even if EPA disapproves it) until the State revises it or EPA promulgates a rule that supersedes it.

— OTHER CONSIDERATIONS —

If a State does not submit standards to EPA, the Agency will attempt to compel submission. EPA may also promulgate water quality standards for the State.

Two important components of State submittals are definitions and general information requested by EPA.

— EPA REVIEW AND APPROVAL —

Both EPA regional offices and Headquarters review the draft and adopted State standards.

EPA checks to see that all seven elements of a standard have been submitted.

EPA reviews State use classifications for waterbodies.

Slide 7: Uses

STATE STANDARDS SUBMISSION MUST INCLUDE:

- Use Classifications Consistent with the Act
- NO Waste Transport or Waste Assimilation Use Classification
- Use Designations for All Waterbodies
- Adequate Use Attainability Analysis

EPA

EPA reviews Use Attainability Analyses.

EPA reviews State-adopted criteria.

Slide 8: Criteria

STATE STANDARDS SUBMISSION MUST INCLUDE:

Criteria Adequate to Protect Designated Uses

- Downstream Uses Protected
- Adequate "Free from" Narrative Criteria
- Adequate Numeric Criteria
- Criteria for Priority Toxic Pollutants

EPA

EPA reviews State's antidegradation policy.

Slide 9: Antidegradation

STATE STANDARDS SUBMISSION MUST INCLUDE:

An Antidegradation Policy That Meets Minimum Requirements of 40 CFR 131.12

EPA

EPA reviews State's basis for designating uses.

Slide 10: Analyses

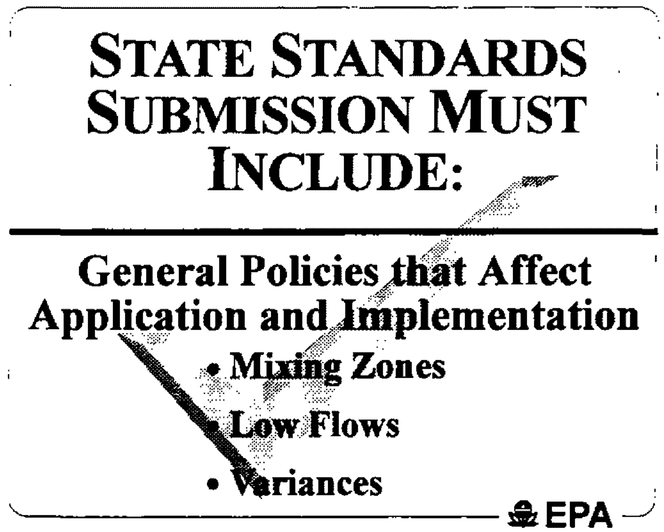
STATE STANDARDS SUBMISSION MUST INCLUDE:

Information on Appropriate Technical and Scientific Data/Analyses To Support Changes in Designated Uses

EPA

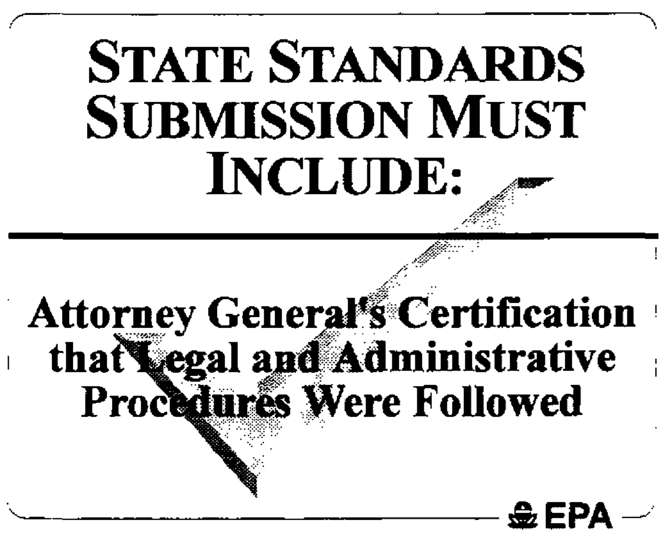
EPA also reviews general policies.

Slide 11: Policies



EPA reviews legal and administrative procedures.

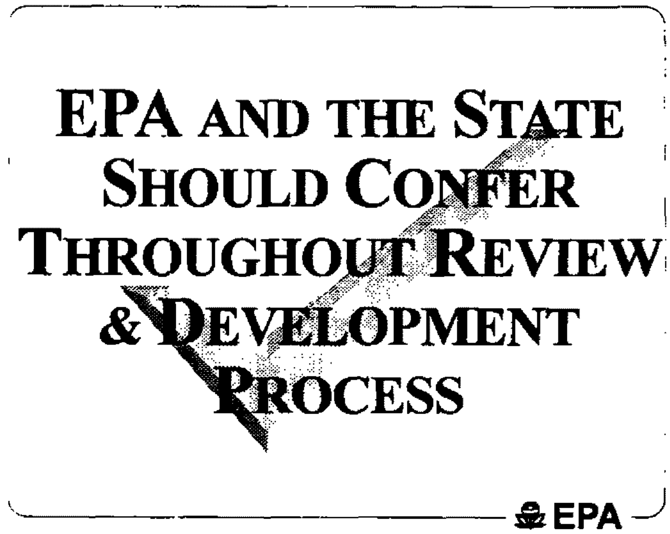
Slide 12: Legal



— REVIEW OPTIONS —

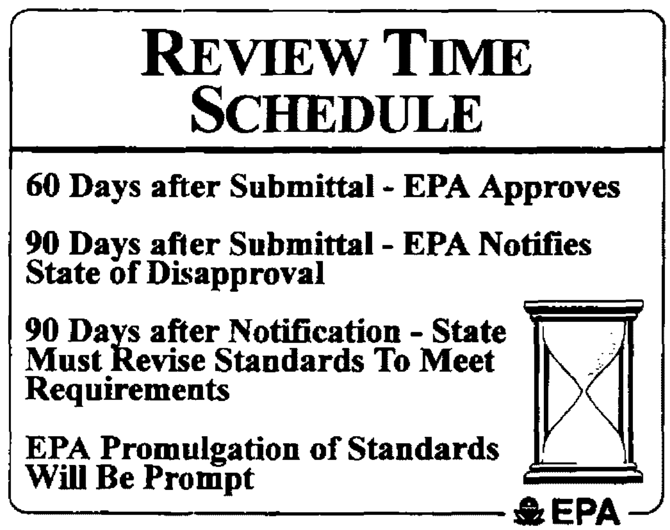
The EPA review process is not subject to formal public review and comment.

Slide 13: Discussions



EPA reviews the time schedule

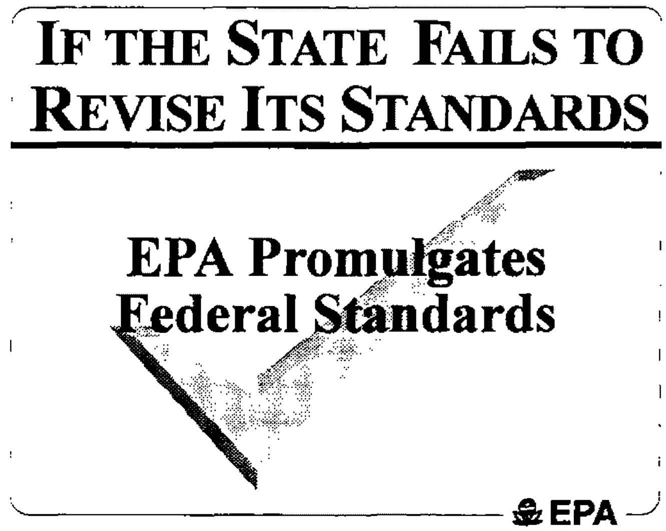
Slide 14: Schedule



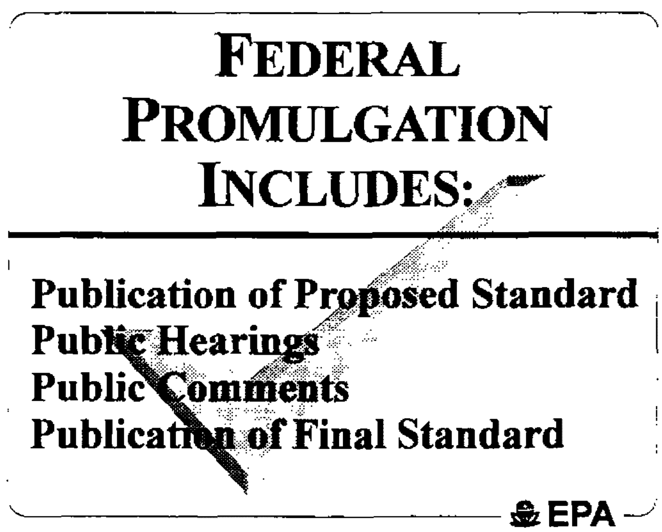
A letter of disapproval will be sent to the Governor (or Governor's designee) specifying what revisions must be adopted to obtain full approval.

Federal promulgation of standards involves a rule-making action taken by the EPA Administrator.

Slide 15: Promulgation-1

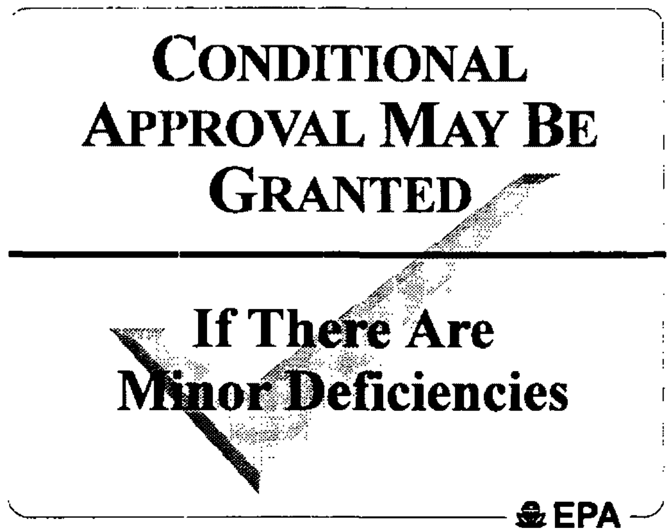


Slide 16: Promulgation-2



Conditional approvals can result in standards that meet the requirements of the CWA without Federal intervention.

Slide 17: Conditional



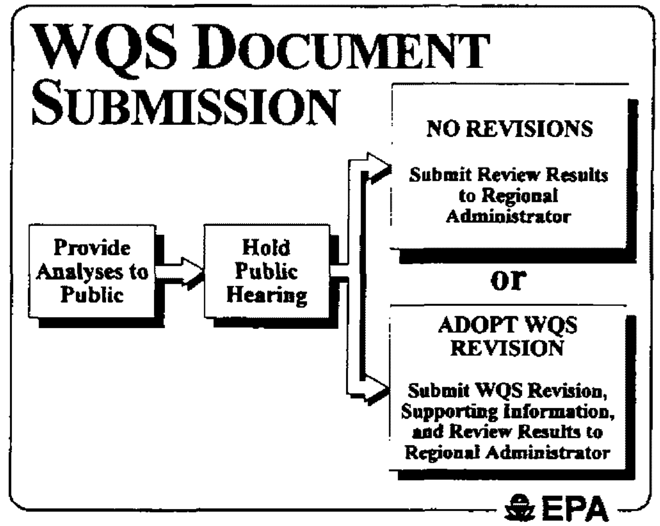
EPA may approve a portion of a State's water quality standards.

Slide 18: Partial

— SUMMARY —

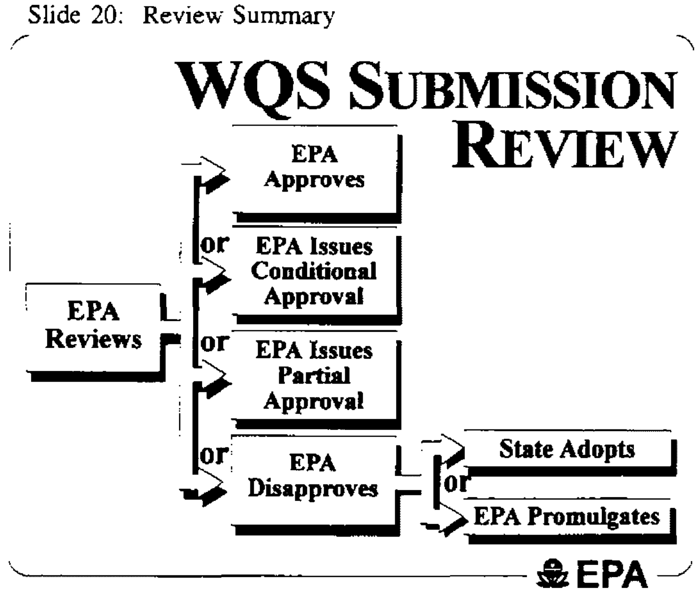
Document submission.

Slide 19: Submission Summary



Submission review.

Slide 20: Review Summary



REVIEW QUESTIONS

1. States are required by statute to review their water quality standards at least once every __ years.

   a. 1
   b. 2
   c. 3
   d. 4

2. The State must submit the results of the review to the EPA regional review for approval within ___ days after taking final action.

   a. 15
   b. 30
   c. 60
   d. 90

3. Which of the following correctly completes this statement? The State Attorney General's certification is important because if EPA disapproves a State's revised standards, ________________.

   a. The previously existing EPA-approved standards remain in place.
   b. No standards are legally applicable until either the State revises the standards again or EPA promulgates Federal standards.
   c. The State-adopted standards remain in effect until either revised by the State or superseded by a federally promulgated standard.
   d. Federal standards automatically apply.

4. True or False. It is possible in some States that a public hearing regarding water quality standards revisions will not be held.

5. True or False. Definitions included in a State's water quality standard cannot be reviewed by EPA, because the Agency can review only standards that are defined as designated uses and the criteria for protecting those uses.

6. True or False. EPA can promulgate State standards if the State does not submit adopted standards.

7. True or False. EPA must either approve or disapprove the entire submission of State standards.

8. What information contained in the State's water quality standards does EPA review?

   a. Uses and criteria only.
   b. Uses, criteria, and antidegradation policy.
   c. EPA reviews all information, including definitions.

9. True or False. Unlike the State's review of standards, EPA's review of State standards and its decision to approve or disapprove is not subject to public notice and comment.

10. True or False. When EPA disapproves standards, the State must submit a new standards package within 60 days.

11. When EPA allows the standards to go into effect but requires the State to perform specific actions in a timely manner, this is known as:

    a. approval
    b. partial approval
    c. conditional approval
    d. delayed approval
    e. disapproval

TRAINING MODULE 19:
THE ENDANGERED SPECIES ACT AND THE WATER QUALITY STANDARDS PROGRAM

MODULE SUMMARY:

This module presents a brief overview of the Endangered Species Act (ESA) and how it relates to the Water Quality Standards (WQS) Program.

OVERALL OBJECTIVES:

To provide an understanding of the relationships between the ESA and the WQS program and the consultation requirements of the ESA.

MEASURABLE OBJECTIVES:

After completing this module, participants should be able to:

- Identify the responsibilities of the EPA and the states in the consultation process
- Describe the differences between formal and informal consultations
- Explain the importance of water quality for endangered species
- Define key terms related to the ESA
- Recognize potential problems associated with the coordination of the ESA and WQS

LOGISTICS

Teaching Method: Lecture with slides.

Approximate Presentation Time: 1 hour (Lecture—45 minutes; Review Questions—15 minutes).

Basic Course Reference Manual Documents:

15 Report to Congress: Recovery Program - Endangered and Threatened Species. 1994. U.S. Department of the Interior. U.S. Fish and Wildlife Service.

COURSE INSTRUCTORS

Charles Abernathy possesses a Ph.D. Degree from North Carolina State in physiology. He completed a post doctoral program at Berkeley in toxicology. For 10 years, Dr. Abernathy conducted research at the Veterans Administration on the pathophysiology of liver.

Dr. Abernathy has worked in EPA's toxic substances program and its drinking water program. He is currently a toxicologist in the Office of Water. Dr. Abernathy has been a Water Quality Standards Academy Instructor since 1993.

Kent Ballentine is one of the principle authors of the existing water quality standards regulation. Kent is Chief of EPA's Regulation and Policy Section in EPA's Standards and Applied Science Division in the Office of Water. He conducts reviews of State and Indian Tribal water quality standards. In addition, Kent provides guidance and assistance to EPA's 10 Regional Water Quality Standard Coordinators. Kent is trained both as an engineer and a lawyer.

George Denning is an economist in the Engineering and Analysis Division within the Office of Science and Technology. He conducts analyses on the economic impacts of effluent guidelines. In the past, he has worked on the State Revolving Fund Program and on drinking water regulations. For the past 15 years, George has also served on the faculty of the Virginia Community College System; he teaches microeconomics and macroeconomics to business leaders, teachers, government executives, and undergraduate students.

Frances A. Desselle is an employee of EPA. Her background is in education and the social sciences. She is responsible for designing and implementing technical assistance, training, education and other outreach and public information programs. These programs are aimed at States, Indian Tribes, environmental, industrial and other groups, including the public-at-large. She also provides technical expertise to other EPA program offices and to other Federal agencies with respect to training, education and technical assistance activities. Frances designed the Water Quality Standards Academy Basic Course and she is charged with the responsibility for implementing it.

George Gibson possesses a Ph.D. Degree from Michigan State University in resource development and water resource management. Dr. Gibson has considerable experience in academia; he has been associated with the University of Wisconsin, Michigan State University and the University of Maryland. Dr. Gibson is the coordinator or EPA's national biological criteria program.

Susan Gilbertson is a program analyst at the EPA where she is responsible for reviewing State and Tribal Water Quality Standards, and developing guidance for use attainability analyses. She has Masters Degrees in cellular immunology from Michigan State University and in public policy from the University of Chicago. Prior to joining EPA/HQ in 1996, she worked in EPA's Regional Office in Chicago. She has worked on a range of Great Lakes issues, including the Great Lakes Water Quality Guidance, Remedial Action Plans and Lakewide Management Plans.

Russell Kinerson is Chief of the Exposure Assessment Branch in the Standards and Applied Science Division (SASD). Among his responsibilities in this branch are the technical aspects of the TMDL Program. Russ came to the Office of Water (OW) in 1991 from the Office of Health and Environmental Assessment in the Office of Research and Development (ORD). Before that he ran the modeling program in the Office of Pollution Prevention and Toxics (OPPT). Before coming to EPA in 1980, Russ taught various ecology courses at the University of New Hampshire. Ecology, mathematical modeling, human and environmental assessments...that sounds like a total maximum daily load in its own right. Or is that an EMMHEA?

Amy Leaberry is an aquatic biologist at EPA. She graduated from Bowling Green State University. Amy has worked with EPA's pretreatment program. She currently develops national aquatic life criteria and she reviews site-specific criterion developed by States and Indian Tribes. Amy has been a Water Quality Standards Academy Instructor since 1993.

Edward V. Ohanian is a Chief Toxicologist and Technical Adviser within EPA's Office of Water. In this capacity, Dr. Ohanian provides expert guidance concerning multimedia risk assessment and science policy issues. Prior to his current position, Dr. Ohanian managed the efforts of a multidisciplinary team of professions responsible for conducting human risk assessments under the Safe Drinking Water Act and Clean Water Act.

Before joining EPA in 1980, Dr. Ohanian was an Adjunct Clinical Associate Professor with the Health Sciences Center at the State University of New York at Stony Brook and a Medical Scientist with the Environmental Health Sciences Program at Brookhaven National Laboratory.

Dr. Ohanian received his Bachelors in Biological Sciences from Columbia University and his Masters in Physiology from the New York Medical College. His Doctorate in Biomedical Sciences was obtained from Mount Sinai School of Medicine in New York. His professional affiliations include the Society of Toxicology, Society for Risk Analysis, Society for Environmental Geochemistry and Health (President, 1987-1989), and American Association for the Advancement of Science.

Neil Patel manages economic and statistical analyses support for the Water Quality Standards and the Effluent Guidelines programs. Prior to that he worked in EPA's Office of Pesticides and Toxic Substances and in the Office of Air and Radiation as the Senior Chemical Engineer supporting the Stratospheric Ozone Protection program. Before joining EPA in 1983, he worked for two major chemical companies for eight years as a senior product development/process engineer.

Mary Reiley possesses a Masters Degree in environmental biology. For the first 6 1/2 years of Mary's tenure at EPA, she worked with EPA's National Pollutant Discharge Elimination Program (NPDES) enforcement program. Currently, she coordinates research in support of sediment quality criteria. She was involved in EPA's Endangered Species Act national consultation effort.

Robert Shippen is an employee of the EPA. He reviews water quality standards adopted by States and Indian Tribes. Prior to joining EPA, Bob worked in the monitoring program with the government of the District of Columbia. Bob has been an Instructor with the Water Quality Standards program since 1991.

Norma Kay Whetzel is employed within EPA's Health and Ecological Criteria Division of the Office of Water. She is trained as a chemist. Her current responsibilities involve development of aquatic life criteria documents and she is a resident expert on metals issues. Before joining the Office of Water, Norma worked in EPA's Office of Pesticides and Toxic Substances where she reviewed experimental data in support of pesticide registration and tolerance levels. Norma has also worked as a bench chemist at the National Institutes of Health in Bethesda, Maryland.

IRIS RECORD FOR CADMIUM

0141
Cadmium: CASRN 7440-43-9 (06/01/92)

Health risk assessment information on a chemical is included in IRIS only after a comprehensive review of chronic toxicity data by work groups composed of U.S. EPA scientists from several Program Offices. The summaries presented in Sections I and II represent a consensus reached in the review process. The other sections contain U.S. EPA information which is specific to a particular Program Office. The regulatory actions in Section IV may not be based on the most current risk assessment, or may be based on a current, but unreviewed, (e.g., treatment technology). When considering the use of regulatory action data for a particular situation, note the date of the regulatory action, the date of the most recent risk assessment relating to that action, and whether technological factors were considered. Background information and explanations of the methods used to derive the values given in IRIS are provided in the five Background Documents in Service Code 5, which correspond to Sections I through V of the chemical files.

STATUS OF DATA FOR Cadmium

File On-Line 03/31/87

Category (section)	Status	Last Revised
Oral RfD Assessment (I.A)	on-line	10/01/89
Inhalation RfC Assessment (I.B)	pending	
Carcinogenicity Assessment (II.)	on-line	06/01/92
Drinking Water Health Advisories (III.A)	no data	
U.S. EPA Regulatory Actions (IV.)	on-line	04/01/92
Supplementary Data (V.)	no data	

_I. CHRONIC HEALTH HAZARD ASSESSMENTS FOR NONCARCINOGENIC EFFECTS

_I.A. REFERENCE DOSE FOR CHRONIC ORAL EXPOSURE (RfD)

Substance Name -- Cadmium
CASRN -- 7440-43-9
Last Revised -- 10/01/89

The Reference Dose (RfD) is based on the assumption that thresholds exist for certain toxic effects such as cellular necrosis, but may not exist for other toxic effects such as carcinogenicity. In general, the RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. Please refer to Background Document 1 in Service Code 5 for an elaboration of these concepts. RfDs can also be derived for the noncarcinogenic health effects of compounds which are also carcinogens. Therefore, it is essential to refer to other sources of information concerning the carcinogenicity of this substance. If the U.S. EPA has evaluated this substance for potential human carcinogenicity, a summary of that evaluation will be contained in Section II of this file when a review of that evaluation is completed.

__ I.A.1. ORAL RFD SUMMARY

Critical Effect	Experimental Doses*	UF	MF	Rfd
Significant proteinuria	NOAEL (water): 0.005 mg/kg/day	10	1	5E-4 mg/kg/day (water)
Human studies involving chronic exposures	NOAEL (food): 0.01 mg/kg/day	10	1	1E-3 mg/kg/day (food)

U.S. EPA, 1985

*Conversion Factors: See text for discussion

<<< Cadmium >>>

__ I.A.2. PRINCIPAL AND SUPPORTING STUDIES (ORAL RfD)

U.S. EPA. 1985. Drinking Water Criteria Document on Cadmium. Office of Drinking Water, Washington, DC. (Final draft)

A concentration of 200 μg cadmium (Cd)/gm wet human renal cortex is the highest renal level not associated with significant proteinuria (U.S. EPA, 1985). A toxicokinetic model is available to determine the level of chronic human oral exposure (NOAEL) which results in 200 μg Cd/gm wet human renal cortex; the model assumes that 0.01% day of the Cd body burden is eliminated per day (U.S. EPA, 1985). Assuming 2.5% absorption of Cd from food or 5% from water, the toxicokinetic model predicts that the NOAEL for chronic Cd exposure is 0.005 and 0.01 mg Cd/kg/day from water and food, respectively (i.e., levels which would result in 200 μg Cd/gm wet weight human renal cortex). Thus, based on an estimated NOAEL of 0.005 mg Cd/kg/day for Cd in drinking water and an UF of 10, an RfD of 0.0005 mg Cd/kg/day (water) was calculated; an equivalent RfD for Cd in food is 0.001 mg Cd/kg/day (see Section VI.A for references).

<<< Cadmium >>>

__ I.A.3. UNCERTAINTY AND MODIFYING FACTORS (ORAL RfD)

UF = 10. This uncertainty factor is used to account for intrahuman variability to the toxicity of this chemical in the absence of specific data on sensitive individuals.

MF = 1.

<<< Cadmium >>>

__ I.A.4. ADDITIONAL COMMENTS (ORAL RfD)

Cd is unusual in relation to most, if not all, of the substances for which an oral RfD has been determined in that a vast quantity of both human and animal toxicity data are available. The RfD is based on the highest level of Cd in the human renal cortex (i.e., the critical level) not associated with significant proteinuria (i.e., the critical effect). A toxicokinetic model has been used to determine the highest level of exposure associated with the lack of a critical effect. Since the fraction of ingested Cd that is absorbed appears to vary with the source (e.g., food vs. drinking water), it is necessary to allow for this difference in absorption when using the toxicokinetic model to determine an RfD.

<<< Cadmium >>>

__ I.A.5. CONFIDENCE IN THE ORAL RfD

Study:	Not applicable
Data Base:	High
RfD:	High

The choice of NOAEL does not reflect the information from any single study. Rather, it reflects the data obtained from many studies on the toxicity of cadmium in both humans and animals. These data also permit calculation of pharmacokinetic parameters of cadmium absorption, distribution, metabolism and elimination. All of this information considered together gives high confidence in the data base. High confidence in either RfD follows as well.

<<< Cadmium >>>

__ I.A.6. EPA DOCUMENTATION AND REVIEW OF THE ORAL RfD

U.S. EPA. 1985. Drinking Water Criteria Document on Cadmium. Office of Drinking Water, Washington, DC. (Final draft)
Agency RfD Work Group Review: 05/15/86, 08/19/86, 09/17/87, 12/15/87, 01/02/88, 05/25/88

Verification Date: 05/25/88

__ I.A.7. EPA CONTACTS (ORAL RfD)

Ken Bailey / ODW -- (202)260-5535 / FTS 260-5535

Warren Banks / OWRS -- (202)260-7893 / FTS 260-7893

_ I.B. REFERENCE CONCENTRATION FOR CHRONIC INHALATION EXPOSURE (RfC)

Substance Name -- Cadmium
CASRN -- 7440-43-9

A risk assessment for this substance/agent is under review by an EPA work group.

_ II. CARCINOGENICITY ASSESSMENT FOR LIFETIME EXPOSURE

Substance Name -- Cadmium
CASRN -- 7440-43-9
Last Revised -- 06/01/92

Section II provides information on three aspects of the carcinogenic risk assessment for the agent in question; the U.S. EPA classification, and quantitative estimates of risk from oral exposure and from inhalation exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in three ways. The slope factor is the result of application of a low-dose extrapolation procedure and is presented as the risk per (mg/kg)/day. The unit risk is the quantitative estimate in terms of either risk per µg/L drinking water or risk per µg/cu.m air breathed. The third form in which risk is presented is a drinking water or air concentration providing cancer risks of 1 in 10,000, 1 in 100,000 or 1 in 1,000,000. Background Document 2 (Service Code 5) provides details on the rationale and methods used to derive the carcinogenicity values found in IRIS. Users are referred to Section I for information on long-term toxic effects other than carcinogenicity.

_ II.A. EVIDENCE FOR CLASSIFICATION AS TO HUMAN CARCINOGENICITY

__ II.A.1. WEIGHT-OF-EVIDENCE CLASSIFICATION

Classification -- B1; probable human carcinogen

Basis -- Limited evidence from occupational epidemiologic studies of cadmium is consistent across investigators and study populations. There is sufficient evidence of carcinogenicity in rats and mice by inhalation and intramuscular and subcutaneous injection. Seven studies in rats and mice wherein cadmium salts (acetate, sulfate, chloride) were administered orally have shown no evidence of carcinogenic response.

<<< Cadmium >>>

__ II.A.2. HUMAN CARCINOGENICITY DATA

Limited. A 2-fold excess risk of lung cancer was observed in cadmium smelter workers. The cohort consisted of 602 white males who had been employed in production work a minimum of 6 months during the years 1940-1969. The population was followed to the end of 1978. Urine cadmium data available for 261 workers employed after 1960 suggested a highly exposed population. The authors were able to ascertain that the increased lung cancer risk was probably not due to the presence of arsenic or to smoking (Thun et al., 1985). An evaluation by the Carcinogen Assessment Group of these possible confounding factors has indicated that the assumptions and methods used in accounting for them appear to be valid. As the SMRs observed were low and there is a lack of clear cut evidence of a causal relationship of the cadmium exposure only, this study is considered to supply limited evidence of human carcinogenicity.

An excess lung cancer risk was also observed in three other studies which were, however, compromised by the presence of other carcinogens (arsenic, smoking) in the exposure or by a small population (Varner, 1983; Sorahan and Waterhouse, 198; Armstrong and Kazantzis, 1983).

Four studies of workers exposed to cadmium dust or fumes provided evidence of a statistically significant positive association with prostate cancer (Kipling and Waterhouse, 1967; Lemen et al., 1976; Holden, 1980; Sorahan and Waterhouse, 1983), but the total number of cases was small in each study. The Thun et al. (1985) study is an update of an earlier study (Lemen et al., 1976) and does not show excess prostate cancer risk in these workers. Studies of human ingestion of cadmium are inadequate to assess carcinogenicity.

<<< Cadmium >>>

__ II.A.3. ANIMAL CARCINOGENICITY DATA

Exposure of Wistar rats by inhalation to cadmium as cadmium chloride at concentrations of 12.5, 25 and 50 μg/cu.m for 18 months, with an additional 13-month observation period, resulted in significant increases in lung tumors (Takenaka et al., 1983). Intratracheal instillation of cadmium oxide did not produce lung tumors in Fischer 344 rats but rather mammary tumors in males and tumors at multiple sites in males (Sanders and Mahaffey, 1984). Injection site tumors and distant site tumors (for example, testicular) have been reported by a number of authors as a consequence of intramuscular or subcutaneous administration of cadmium metal and chloride, sulfate, oxide and sulfide compounds of cadmium to rats and mice (U.S. EPA, 1985). Seven studies in rats and mice where cadmium salts (acetate, sulfate, chloride) were administered orally have shown no evidence of a carcinogenic response.

<<< Cadmium >>>

__ II.A.4. SUPPORTING DATA FOR CARCINOGENICITY

Results of mutagenicity tests in bacteria and yeast have been inconclusive. Positive responses have been obtained in mutation assays in Chinese hamster cells (Dom and V79 lines) and in mouse lymphoma cells (Casto, 1976; Ochi and Ohsawa, 1983; Oberly et al., 1982).

Conflicting results have been obtained in assays of chromosomal aberrations in human lymphocytes treated in vitro or obtained from exposed workers. Cadmium treatment in vivo or in vitro appears to interfere with spindle formation and to result in aneuploidy in germ cells of mice and hamsters (Shimada et al., 1976; Watanabe et al., 1979; Gilliavod and Leonard, 1975).

---------<<< Cadmium >>>---------

__ II.B. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM ORAL EXPOSURE

Not available. There are no positive studies of orally ingested cadmium suitable for quantification.

---------<<< Cadmium >>>---------

__ II.C. QUANTIFICATION ESTIMATE OF CARCINOGENIC RISK FROM INHALATION EXPOSURE

__ II.C.1. SUMMARY OF RISK ESTIMATES

Inhalation Unit Risk -- 1.8E-3 per (μg/cu.m)

Extrapolation Method -- Two stage; only first affected by exposure; extra risk

Air Concentrations at Specified Risk Levels

Risk Level	Concentration
E-4 (1 in 10,000)	6E-2 µg/cu.m
E-5 (1 in 100,000)	6E-3 µg/cu.m
E-6 (1 in 1,000,000)	6E-4 µg/cu.m

<<< Cadmium >>>

__ II.C.2. DOSE-RESPONSE DATA FOR CARCINOGENICITY, INHALATION EXPOSURE

Tumor Test -- lung, trachea, bronchus cancer deaths
Test Animals -- human/white male
Route -- inhalation, exposure in the workplace
Reference -- Thun et al., 1985

Cumulative Exposure (mg/day/cu.m)	Median Observation	24 hour/µg/cu.m Equivalent	No. of Expected lung, Trachea and Bronchus Cancers Assuming No Cadmium Effect	Observed No. of Deaths (lung, trachea, bronchus cancers)
less than or equal to 584	280	168	3.77	2
585-2920	1210	727	4.61	7
greater than or equal to 2921	4200	2522	2.5	7

The 24-hour equivalent = median observation x 1E+3 x 8/24 x 1/365 x 240/365.

<<< Cadmium >>>

__ II.C.3. ADDITIONAL COMMENTS (CARCINOGENICITY, INHALATION EXPOSURE)

The unit risk should not be used if the air concentration exceeds 6µg/cu.m, since above this concentration the unit risk may not be appropriate.

<<< Cadmium >>>

__ II.C.4. DISCUSSION OF CONFIDENCE (CARCINOGENICITY, INHALATION EXPOSURE)

The data were derived from a relatively large cohort. Effects of arsenic and smoking were accounted for in the quantitative analysis for cadmium effects.

An inhalation unit risk for cadmium based on the Takenaka et al. (1983) analysis is 9.2E-2 per (µg/cu.m). While this estimate is higher than that derived from human data [1.8E-3 per (µg/cu.m)] and thus more conservative, it was felt that the use of available human data was more reliable because of species variations in response and the type of exposure (cadmium salt vs. cadmium fume and cadmium oxide.)

---------<<< Cadmium >>>---------

_ II.D. EPA DOCUMENTATION, REVIEW, AND CONTACTS (CARCINOGENICITY ASSESSMENT)

__ II.D.1. EPA DOCUMENTATION

U.S. EPA. 1985. Updated Mutagenicity and Carcinogenicity Assessment of Cadmium: Addendum to the Health Assessment Document for Cadmium (May 1981, EPA 600/B-B1-023). EPA 600/B-83-025F.

The Addendum to the Cadmium Health Assessment has received both Agency and external review.

<<< Cadmium >>>

__ II.D.2 REVIEW (CARCINOGENICITY ASSESSMENT)

Agency Work Group Review -- 11/12/86

Verification Date -- 11/12/86

__ II.D.3. EPA CONTACTS (CARCINOGENICITY ASSESSMENT)

William E. Pepelko / ORD -- (202)260-5904 / FTS 260-5904

David Bayliss / ORD -- (202)260-5726 / FTS 260-5726

_ III. HEALTH HAZARD ASSESSMENTS FOR VARIED EXPOSURE DURATIONS

_ III.A. DRINKING WATER HEALTH ADVISORIES

Substance Name -- Cadmium
CASRN -- 7440-43-9

Not available at this time

_ III.B. OTHER ASSESSMENTS

Substance Name -- Cadmium
CASRN -- 7440-43-9

Content to be determined.

_ IV. US EPA REGULATORY ACTIONS

Substance Name -- Cadmium
CASRN -- 7440-43-9
Last Revised -- 04/01/92

EPA risk assessments may be updated as new data are published and as assessment methodologies evolve. Regulatory actions are frequently not updated at the same time. Compare the dates for the regulatory actions in this section with the verification dates for the risk assessments in sections I and II, as this may explain inconsistencies. Also note that some regulatory actions consider factors not related to health risk, such as technical or economic feasibility. Such considerations are indicated for each action. In addition, not all of the regulatory actions listed in this section involve enforceable federal standards. Please direct any questions you may have concerning these regulatory actions to the U.S. EPA contact listed for that particular action. Users are strongly urged to read the background information on each regulatory action in Background Document 4 in Service Code 5.

_ IV.A. CLEAN AIR ACT (CAA)

No data available.

---------<<< Cadmium >>>---------

_ IV.B. SAFE DRINKING WATER ACT (SDWA)

__ IV.B.1. MAXIMUM CONTAMINANT LEVEL GOAL (MCLG) for Drinking Water

Value (status) -- 0.005 mg/L (Final, 1991)

Considers technological or economic feasibility? -- NO

Discussion -- Cadmium has been classed as a Category III contaminant with an MCLG of 0.005 mg/L based upon reports of renal toxicity in humans. The MCLG is based upon a DWEL of 0.018 mg/L and an assumed drinking water contribution (plus aquatic organisms) of 25 percent. An uncertainty factor of 10 was also applied.

Reference -- 56 FR 3526 (01/30/91)

EPA Contact -- Health and Ecological Criteria Division / OST / (202)260-7571 / FTS 260-7571; or Safe Drinking Water Hotline / (800) 426-4791

<<< Cadmium >>>

__ IV.B.2. MAXIMUM CONTAMINANT LEVEL (MCL) for Drinking Water

Value (status) -- 0.005 mg/L (Final, 1991)

Considers technological or economic feasibility? -- YES

Discussion -- EPA has promulgated an MCL equal to the established MCLG or 0.005 mg/L.

Monitoring requirements -- Ground water systems monitored every three years; surface water systems monitored annually; systems out of compliance must begin monitoring quarterly until system is reliably and consistently below MCL.

Analytical methodology -- Atomic absorption/ furnace technique (EPA 213.2; SM 304); inductively coupled plasma (200.7): PQL= 0.002 mg/L.

Best available technology -- Coagulation/filtration; ion exchange; lime softening; and reverse osmosis.

Reference -- 56 FR 3526 (01/30/91)

EPA Contact -- Drinking Water Standards Division / OGWDW / (202)260-7575 / FTS 260-7575; or Safe Drinking Water Hotline / (800)426-4791

<<< Cadmium >>>

__ IV.B.3. SECONDARY MAXIMUM CONTAMINANT LEVEL (SMCL) for Drinking Water

No data available.

<<< Cadmium >>>

__ IV.B.4. REQUIRED MONITORING OF "UNREGULATED" CONTAMINANTS

No data available.

---------<<< Cadmium >>>---------

__ IV.C. CLEAN WATER ACT (CWA)

__ IV.C.1. AMBIENT WATER QUALITY CRITERIA, Human Health

Water and Fish Consumption: 1E+1 µg/L

Fish Consumption Only: None

Considers technological or economic feasibility? -- NO

Discussion -- The criteria is the same as the existing standard for drinking water.

Reference -- 45 FR 79318 (11/28/80)

EPA Contact -- Standards and Applied Science Division / OWRS (202)260-1315 / FTS 260-1315

<<< Cadmium >>>

__ IV.C.2. AMBIENT WATER QUALITY CRITERIA, Aquatic Organisms

Freshwater:

Acute -- 3.9E+0 µg/L (1-hour average)
Chronic -- 1.1E+0 µg/L (4-day average)

Marine:

Acute -- 4.3E+1 µg/L (1-hour average)
Chronic -- 9.3E+0 µg/L (4-day average)

Considers technological or economic feasibility? -- NO

Discussion -- Criteria were derived from a minimum data base consisting of acute and chronic tests on a variety of species. The freshwater criteria are hardness dependent. Values given here are calculated at a hardness of 100 mg/L CaCO3. A complete discussion can be found in the referenced notice.

Reference -- 50 FR 30784 (07/29/85)

EPA Contact -- Criteria and Standards Division / OWRS (202)260-1315 / FTS 260-1315

---------<<< Cadmium >>>---------

__ IV.D. FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT (FIFRA)

__ IV.D.1. PESTICIDE ACTIVE INGREDIENT, Registration Standard

Status -- Voluntary Cancellation [cadmium chloride] (1990)

Reference -- 55 FR 31227 (08/01/90)

EPA Contact -- Registration Branch / OPP / (703)557-7760 / FTS 557-7760

<<< Cadmium >>>

__ IV.D.2. PESTICIDE ACTIVE INGREDIENT, Special Review

Action -- Termination of Special Review (1991)

Considers technological or economic feasibility? -- YES

Summary of regulatory action -- All uses of cadmium pesticides canceled.
Criterion of concern: oncogenicity, mutagenicity, teratogenicity, and fetotoxicity.

Reference -- 56 FR 14522 (04/10/91)

EPA Contact -- Special Review Branch / OPP (703)557-7400 / FTS 557-7400

---------<<< Cadmium >>>---------

_ IV.E. TOXIC SUBSTANCES CONTROL ACT (TSCA)

No data available.

---------<<< Cadmium >>>---------

_IV.F. RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

__ IV.F.1. RCRA APPENDIX IX, for Ground Water Monitoring

Status -- Listed

Reference -- 52 FR 25942 (07/09/87)

EPA Contact -- RCRA/Superfund Hotline (800)424-9346 / (202)260-3000 / FTS 260-3000

---------<<< Cadmium >>>---------

_ IV.G. SUPERFUND (CERCLA)

__ IV.G.1. REPORTABLE QUANTITY (RQ) for Release into the Environment

Value (status) -- 10 pounds (Final, 1989)

Considers technological or economic feasibility? -- NO

Discussion -- The RQ for cadmium is 10 pounds, based on potential carcinogenicity. Available data indicate a hazard ranking of medium, based on a potency factor of 57.87/mg/kg/day and weight-of-evidence group B1, which corresponds to an RQ of 10 pounds. Cadmium has also been found to bioaccumulate in the tissues of aquatic and marine organisms, and has the potential to concentrate in the food chain. Reporting of releases of massive forms of this hazardous substance is not required if the diameter of the pieces released exceeds 100 micrometers (0.004 inches).

Reference -- 54 FR 33418 (08/14/89)

EPA Contract -- RCRA/Superfund Hotline (800)424-9346 / (202)260-3000 / FTS 260-3000

_ V. SUPPLEMENTARY DATA

Substance Name -- Cadmium
CASRN -- 7440-43-9

Not available at this time.

_ IV. BIBLIOGRAPHY

Substance Name -- Cadmium
CASRN -- 7440-43-9
Last Revised -- 10/01/89

VI.A. ORAL RfD REFERENCES

Foulkes, E.C. 1986. Absorption of cadmium. In: Handbook of Experimental Pharmacology, E.C. Foulkes, Ed. Springer Verlag, Berlin. Vol. 80, p. 75-100.

Friberg, L., M. Piscator, G.F. Nordberg and T. Kjellstrom. 1974. Cadmium in the environment, 2nd ed. CRC Press, Inc., Boca Raton, FL.

Shaikh, Z.A. and J.C. Smith. 1980. Metabolism of orally ingested cadmium in humans. In: Mechanisms of Toxicity and Hazard Evaluation, B. Holmstedt et al., Ed. Elsevier Publishing Co., Amsterdam. p. 569-574.

U.S. EPA. 1985. Drinking Water Criteria Document on Cadmium. Office of Drinking Water, Washington, DC. (Final draft)

WHO (World Health Organization). 1972. Evaluation of certain food additives and the contaminants mercury, lead, and cadmium. Sixteenth Report of the Joint FAO/WHO Expert Committee on Food Additives. WHO Technical Report Series No. 505, FAO Nutrition Meetings Report Series No. 51. Geneva, Switzerland.

WHO (World Health Organization). 1984. Guidelines for drinking water quality -- recommendations. Vol. 1. Geneva, Switzerland.

---------<<< Cadmium >>>---------

_ VI.B. INHALATION RfD REFERENCES

None

---------<<< Cadmium >>>---------

_ VI.C. CARCINOGENICITY ASSESSMENT REFERENCES

Armstrong, B.G. and G. Kazantzis. 1983. The mortality of cadmium workers. Lancet. June 25, 1983: 1425-1427.

Casto, B. 1976. Letter to Richard Troast, U.S. EPA. Enclosing mutagenicity data on cadmium chloride and cadmium acetate.

Gilliavod, N. and A. Leonard. 1975. Mutagenicity tests with cadmium in the mouse. Toxicology. 5: 43-47.

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Kipling, M.D. and J.A.H. Waterhouse. 1967. Cadmium and prostatic carcinoma. Lancet. 1: 730.

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----------<<< Cadmium >>>---------

_ VI.D. DRINKING WATER HA REFERENCES

None

_ VII. REVISION HISTORY

Substance Name -- Cadmium
CASRN -- 7440-43-9

Date	Section	Description
05/21/87	II.C	Slope factor corrected
03/01/88	II.A.1.	Text added
03/01/88	II.C.3.	Text revised
03/01/88	II.C.4.	Confidence statement revised
03/01/88	II.D.3.	Secondary contact changed
01/01/89	IV.C.1.	Water quality human health criteria added
01/01/89	IV.C.2.	Corrected marine acute criterion
08/01/89	VI.	Bibliography on-line
10/01/89	I.A.	Oral RfD summary on-line
10/01/89	VI.A.	Oral RfD references added
12/01/89	I.B.	Inhalation RfD now under review
06/01/90	IV.A.1.	Area code for EPA contact corrected
06/01/90	II.F.1	EPA contact changed
08/01/90	II.A.1.	Basis statement revised
08/01/90	II.A.2.	Text revised, paragraph 1
08/01/90	II.B.	Text revised
01/01/91	II.	Text edited
01/01/91	II.C.1.	Inhalation slope factor removed (global change)
03/01/91	II.A.1.	Text revised
03/01/91	II.B.	Text revised
01/01/92	IV.	Regulatory actions updated
04/01/92	IV.A.1.	CAA regulatory action withdrawn
05/01/92	II.C.2.	Number correction in data table
06/01/92	II.A.2.	Text revised, paragraph 1
06/01/92	II.A.3	Text clarified

SYNONYMS

Substance Name -- Cadmium
CASRN -- 744-43-9
Last Revised -- 03/31/87

7440-43-9
C.I. 77180
Cadmium
KADMIUM

Decisions to Be Made Before the Procedures for Developing Site-Specific Criteria Are Initiated

Verify that site-specific criteria are actually needed (e.g., the use of clean sampling and/or analytical techniques did not result in the attainment of current standards).

Define the site boundaries.

Determine whether data (in the national criterion document or other sources) indicate that the range of sensitivity of the selected resident species to the material of interest is different from that in the national criterion document. (The variation in physical/chemical characteristics of site water is not expected to be a factor.).

Determine from the national criterion document and other sources if physical and/or chemical characteristics are known to affect the bioavailability and/or toxicity of the material of interest. (The range of sensitivity of resident species is similar to that used for the national criterion document.)

Use the Recalculation Procedure.

Use the Water-Effect Ratio Procedure.

If both of these conditions exist and are to be taken into account, use the Recalculation Procedure in conjunction with the Water-Effect Ratio Procedure
OR
Use the Resident Species Procedure.

DEVELOPMENT OF SITE-SPECIFIC CRITERIA

NOTE: This exercise provides a highly simplified example of some of the considerations and processes States or dischargers need go through to develop site-specific criteria. For more complete step-by-step procedures and discussion of which steps require prior U.S. EPA approval, please refer to Appendix L of the *Water Quality Standards Handbook*, included as Tab 4 of your Reference Manual.

INSTRUCTIONS: Read the following scenario and then the class will read the review questions together. The instructor will call on individuals to answer the questions.

Gob Bog, located near a former mining operation, in Newlandia (our 51st state) has been monitored by the Newlandia Water Quality Agency quarterly for the last 5 years for water quality parameters including both total and dissolved metals concentrations. Both the total and dissolved concentrations of metallium have been found to consistently exceed the criterion continuous concentration (CCC) listed in the national criterion document for metallium (5 μg/L). The national CCC for metallium was calculated from the Genus Mean Acute Values (GMAVs) of salmonids, catfish, amphipods, and mayflies and acute-to-chronic ratios. Newlandia does not yet have State water quality criteria established.

The bog is approximately 300 acres in size and has an average depth of 1 foot in the rainy months, although it dries down in summer months. The bog does not provide habitat for any species of bony fish for any part of their life cycles, and none of the species in the bog are considered to have recreational or commercial importance. It does, however, provide critical habitat for several aquatic insects, macroinvertebrates, and amphibians, including the endangered Sally's salamander (*Sallius salamanderus*). The most notable water quality characteristics of this bog include a slightly lowered pH (slightly acidic) and a hardness of 60 mg/L. (Average or default water hardness is usually considered to be approximately 100 mg/L.)

Sally Mander is a citizen of Newlandia who, in the early 1900s, actually discovered and named the now endangered Sally's salamander. Her son, a professor of biology at Newlandia University, oversees graduate work conducted at the bog. Because of her intimate involvement with this species, Mrs. Mander has carefully tracked the decline of the salamander for decades. Mrs. Mander, her son, and several graduate students have collected data and performed toxicity tests that demonstrate the salamander's sensitivity to metallium and have sent the data to U.S. EPA for approval.

1. There are at least three reasons why derivation of a site-specific criterion might be considered at this site. List as many as you can.

2. Our site is defined as the bog only. Before the site-specific criterion derivation procedure is initiated, some data quality issues should be considered. What are these?

3. It turns out that the quality of the water monitoring data for the Gob Bog is satisfactory. What procedures should we use to derive site-specific criteria in this case? Why?

4. If you selected the Recalculation Procedure (by itself or in conjunction with the Water-Effect Ratio [WER] Procedure), you should read through the simplified steps listed under this item number and answer the appropriate questions. Remember, if the two procedures are to be used together, the Recalculation Procedure should be completed first.

NOTE: The National Toxics Rule does not allow the use of the Recalculation Procedure to develop site-specific criteria. Newlandia is not within a National Toxics Rule jurisdiction.

a. Make any U.S. EPA-approved corrections to the national data set. This is a requirement for the Recalculation Procedure. No corrections are necessary at this time.

b. Make U.S. EPA-approved additions to the national data set. Mrs. Mander started this process for Newlandia. Newlandia has received approval from U.S. EPA on the GMAV and chronic value for Sally's salamander calculated at Newlandia University and published in the Ecotox Journal of Science.

c. Apply the deletion process, if desired. More than half of the national data set for metallium was composed of data for bony fish; however, no bony fish occur in this bog. Although the bog does not provide habitat for salmonids and a second fish family recommended as the minimum data set for freshwater criterion derivation, the variety of aquatic invertebrates and amphibians is sufficient to allow us to meet the eight-family minimum data set; therefore, we can proceed with the Recalculation Procedure. Do you think the deletion of bony fish from the national data set will result in a lowering or raising of the criterion?

d. Determine the new CCC or criterion maximum concentration (CMC) or both. The table below presents the revised data base at the genus level. Using what was presented in the module and in Handout 9-9, briefly describe the procedures used to determine the new CMC and CCC.

Scientific name	Common name	(N)ational or (S)ite Data Set	Chronic Value	GMAV Rank
Stylaria spp.	annelid worm	N, S	available	6
Tubifex spp.	tubificid worm	N, S	N/A	5
Libellula spp.	dragonfly	N, S	available	2
Daphnia spp.	daphnid	N, S	available	3
Amnicola spp.	snail	N, S	N/A	8 (highest)
Rana spp.	pickerel frog (egg)	N, S	N/A	7
Bufo americanus	toad (egg)	N, S	N/A	4
Sallius spp.	Sally's salamander (egg)	S	available	1 (lowest)

e. Report all findings to U.S. EPA for approval. Our resulting criterion for metallium is 0.5 µg/L.

5. If you selected the WER Procedure, you should read through the simplified steps listed under this item number and answer the appropriate questions. The WER concept involves two side-by-side toxicity tests—one test using laboratory dilution water and the other using site water. The endpoint obtained using site water is divided by the endpoint obtained using laboratory dilution water. The quotient is the WER, which is multiplied by the national, state, or recalculated aquatic life criterion to calculate the site-specific criterion.

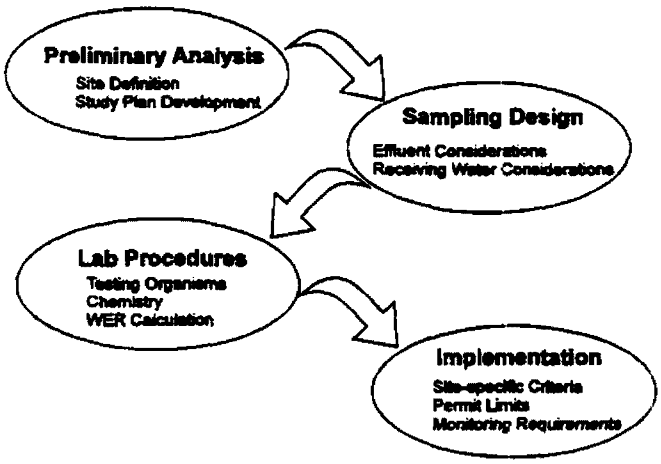
   a. Before initiating the WER Procedure, it is extremely important that all attempts at clean sampling and analytical procedures have been made. The WER Procedure often derives a ratio of 1 or very close to 1 (i.e., having little, if any, effect on the national criteria) and is expensive to implement. The WER procedure may be used with only certain metals. For the purposes of our example, we will pretend that metallium is one of these.

   b. Second, a method of deriving WERs is selected. The following two methods are available: Method 1 for determining WERs for areas in or near plumes, and Method 2 for determining WERs for areas away from plumes. Because the bog is located near the former mining operation, the bog has been determined to be within the plume; therefore, we will use Method 1.

c. The following flow chart gives an indication of the actual procedures involved in the WER process. Based on what you know about the Newlandia bog, do you think the WER will effectively raise or lower the criterion for metallium?

If the site water endpoint was 2.0 µg/L and the laboratory water endpoint was 4.0 µg/L, what is the final resulting site-specific criterion based on the methods you selected?

WER Implemenation



Developing Site-Specific Criteria

Video Transcript
36 minutes

U.S. EPA
Office of Water
Office of Science and Technology
Standards and Applied Science Division

In this presentation we will discuss the development of site-specific numeric criteria for aquatic life and the role they play in the water quality standards and criteria process. As part of our discussion, we will focus on the indicator species criteria, one of the procedures which may be used to develop numeric site-specific criteria.

To bring more meaning to the discussion, we first need to understand a few of the important aspects of the water quality standards and criteria programs. Under the Clean Water Act, States, Territories and Indian Tribes that are authorized to administer the water quality standards are required to set water quality standards. Throughout this presentation, when I say "States," I am also including Territories and Indian Tribes that are authorized to administer the program.

Water quality standards are laws or regulations that consist of the designated use of a waterbody, or segment of a waterbody, and the water quality criteria necessary to protect the designated use. In addition to uses and criteria, water quality standards must contain an antidegradation policy and a method for implementing it. Examples of uses are: public water supply; fishing, swimming and boating, agricultural and industrial water supply; navigation; and other such purposes. Keep in mind, uses may exist currently, or they may be goals that could be obtained in the future with improved water quality. As mentioned, criteria are designed to protect and support the use or uses.

Criteria can be expressed as numeric concentration limits on a particular chemical that protect and support a use, or as a narrative description of a condition of a waterbody that protects and supports a use. When criteria are met, the quality of the water should be such that it protects the designated uses. Today, EPA has published criteria to protect both human health and aquatic life.

Today we'll be focusing on developing site-specific aquatic life criteria. EPA's guidance for aquatic life criteria is generally used by the States as the basis for developing water quality criteria in their water quality standards. EPA's criteria guidance is based on a broad spectrum of data and is generally sufficient to protect the aquatic life in all waterbodies.

These criteria, although broad, may be adjusted to reflect localized site-specific conditions when the national criteria appear to be either significantly over- or under-protective. Water quality criteria developed for a specific area is referred to as site-specific criteria. Later in this presentation, I'll discuss the definition of a site. It does not necessarily mean a small localized area. The need for this site-specific approach may be due to differences in pollution sensitivity of an indigenous biological community or in the water chemistry of a specific site as it affects toxicity of a chemical.

States have a choice of adopting EPA's water quality criteria or adopting other criteria which are scientifically defensible, including site-specific criteria. Thus, local conditions can be used to derive criteria for a given waterbody at the option of a State. The process for developing site-specific criteria evolves from EPA's national criteria development methodology. This presentation is based on site-specific toxicity testing. Because EPA's national criteria is determined in clean water, as it is intended to provide criteria applicable to virtually all waters in the entire nation, it may be over- or under-protective at any specific site.

Keep in mind, some naturally occurring substances and some introduced substances are able to chemically combine with metals and probably other pollutants. This occurrence in the ambient water can affect the bioavailability of the pollutant. In other words, we want to determine how the pollutant affects the test organism in site water when compared with its affect in laboratory water as presented in EPA's criteria document.

Assessing bioavailability and establishing site-specific criteria for a pollutant can only be done currently with the use of biologically-based approaches. Scientific knowledge has not yet progressed to allow methods, for example chemically-based procedures.

The first step to establishing site-specific criteria is to look at species sensitivity. To determine if the species present at the site are either more sensitive or less sensitive than those included in the National Criteria Database used by EPA. Thus, a recalculation adjustment is based on the sensitivity of the biological community at the site. If the recalculation procedure is insufficient or inappropriate, the second step requires biological toxicity testing.

Let's proceed with our discussion of developing site-specific criteria. Specifically, we're talking about scientifically determined site-specific numeric criteria to protect aquatic life. We won't be covering the narrative-based criteria in this presentation.

Water quality criteria generally apply statewide, depending on the specificity with which each State identifies the aquatic life to be protected and on the type of waterbody. The physical, chemical or biological characteristics of certain waterbodies within a State may be so different that the national or statewide water quality criteria might be over- or, infrequently, under-protective. In such situations, States, at their option, may use numeric criteria that are specific to each site. Thus the site-specific numeric criteria replace the statewide numeric standards for a specific waterbody.

Once again, one reason it may be desirable to develop site-specific criteria is that an aquatic life community that occurs in a particular waterbody may be either more or less sensitive to a pollutant than the aquatic organisms used to develop the state of EPA criteria. For example, the National Criteria Database contains data for various species of trout for fresh waters and pennate shrimp for marine waters. These species represent aquatic life families known to be especially sensitive to certain chemicals. However, these or other sensitive species may not occur naturally at a particular site. They may not be representative of those species that do occur at the site. Conversely, untested sensitive resident species may exist at a site, and they may need to be protected because they may be ecologically or economically important.

Another reason for developing site-specific criteria is because of differences in the physical and chemical characteristics of the water itself. For example, it may be demonstrated in the laboratory that the characteristics of the water increase or decrease the toxicity of chemicals in the water, as compared with waters used in developing the national criteria. This applies to freshwater and saltwater environments. Such characteristics of water include hardness, concentrations of particulate matter, or dissolved organic matter.

Next, let's look at how site-specific criteria are proposed. Any person, municipality, corporation, or organization can propose site-specific criteria to a State. The entity making the proposal needs to provide that data, and other information justifying the proposed site-specific criterion. Here's a very important point: after determining the site-specific criterion, you may find that the result is a numeric limit that is equal to, more stringent than, or less stringent than EPA's national recommendation. The State must review the data in the proposal, and review the procedures that were used to collect and analyze the data. The State must then make a determination whether or not to adopt the proposed site-specific criterion. If adopted, EPA then must review and approve, or disapprove, the site-specific criterion.

Let's review the three procedures, or protocols, which may be used to develop the numeric site-specific criteria. They are: the recalculation procedure, the indicator species procedure (also known as the water affect ratio procedure), and the resident species procedure. The resident species procedure may involve significant amounts of toxicity testing almost equivalent to complete development of a criterion by EPA's methodology, and is therefore beyond the scope of this discussion.

The recalculation procedure may be used in situations where data exist which indicate that the sensitivity of the species that occur at the site may be different from the sensitivity of one or more of the species used by EPA to develop national criteria. This procedure does not directly consider the physical and/or chemical characteristics of the site's water.

The indicator species, or water affect ratio procedure, may be used in situations where the indigenous aquatic species and the species used to develop EPA's national criteria exhibit similar sensitivity to pollutants of concern; but where the physical and/or chemical characteristics of the site's water may result in differences between the local site and EPA criteria in terms of bioavailability and/or toxicity of the pollutant of concern.

The recalculation procedure and the water affect ratio may be used together in certain situations. However, the recalculation procedure must be performed first.

Please note: site-specific criteria can be developed for both acute and chronic criteria. Acute criteria protect aquatic life from rapidly induced affects, usually death, in a short period of time. Chronic criteria protect aquatic life from adverse stimulus that lingers or continues for a relatively long period of time.

Before we go into more detail on the protocols, it's important to know and understand the definition of a site. A site may be an area affected by a single point source discharge, or it may be quite a large area encompassing an entire segment of a waterbody, such as a stream segment affected by several discharges. It can even be an entire State. For example, large portions of a waterbody, such as parts of the Chesapeake Bay, Lake Michigan, or the Ohio River, may be considered sites. They may be considered as one site because we may find that their respective aquatic communities or water quality characteristics may be similar. Unique populations, or less sensitive uses of a segment of a waterbody, may justify a designation as a distinct site or sub-site.

Let's look at a hypothetical example which is based on an actual site. Here's the situation:

> The site is a waterbody we will classify as a river basin. The State examined the river site because high metal loadings to the river resulted in occasional exceedances of its water quality criteria for lead and zinc under design flow conditions. There are two point source discharges of treated sewage located upstream from where water sampling will take place. One publicly owned treatment work (POTW) discharges roughly 400,000 gallons per day of treated sewage near the headwaters of the stream, 13.5 miles upstream from where water sampling will take place. By the way, a POTW is a waste treatment facility owned by a State, local government or Indian Tribe to treat wastewater. A second POTW discharges 350,000 gallons per day of treated sewage to the river 9 miles upstream from the sampling area. Although water quality is degraded somewhat in the immediate vicinity of these pollutant sources as the river flows downstream, it recovers to support a valuable recreational trout fishery. There is also a

manufacturing company within the study area that discharges metal containing treated processed water to the river. The manufacturing facility cleans, draws and coats metal wire. Wastewater is generated during the wire cleaning and coating processes. The treated wastewater is discharged intermittently to the river. The company's NPDES permit is due for renewal. The NPDES (National Pollutant Discharge Elimination System) of this company specifies an allowable daily discharge limit for lead and zinc. NPDES permits limit the quantity of pollutants discharged to a body of water.

An evaluation by the State indicated that given the present level of lead and zinc in the industrial discharge, in comparison to the State criteria for these metals, aquatic communities should show evidence of impact downstream from the point of release. In the evaluation, acute and chronic State criteria for lead and zinc, which were the same as the national criteria, were compared with calculated instream concentrations of the same metals. These calculations were made for the design low flow condition.

In terms of instream biota in the control zone "C1" upstream from the study area, the biological community can be characterized as diverse, with many species being classified as sensitive with respect to pollution tolerance. The combination of high species diversity and pollution sensitive species indicate good water quality.

Downstream from the two POTW discharges the community composition and the diversity of taxa remained acceptable in comparison with the upstream controlled community. The downstream community exhibited the effects of organic enrichment, but not toxicity. While the bottom dwelling organism community downstream did not return to or recover from conditions present in the upstream control zone, it was deemed satisfactory. Thus, there was evidence that the State criteria failed to predict the actual instream condition, so the State decided to establish site-specific criteria.

In order to evaluate the effect of the site's water on the toxicity of lead and zinc, it was decided to use site-specific criteria modification protocol. The indicator species procedure was chosen for this evaluation. Remember, the indicator species, or water- effect ratio procedure, assumes the sensitivity of the aquatic species at the site to the pollutant of concern is similar to that of the species used to develop the EPA national criteria, and that physical and/or chemical characteristics of the site's water may result in differences in terms of bio-availability and/or toxicity of the pollutant. Therefore, it accounts for the effective toxicity of a chemical as a function of site water quality parameters, such as pH, hardness, dissolved organic materials, and the presence of other contaminants.

In this hypothetical example, the organic materials discharged by the POTW seem to reduce the toxicity of zinc and lead discharged by the industry. EPA's 1993 recommended approach for determining water-effect ratios for metals, recommends testing of a sensitive primary species on at least three separate occasions, with a confirmation test on a secondary species on at least one of those occasions. In our example, the State used a daphnia species as the primary test and rainbow trout as the confirmatory test. Here's how:

> The river water was withdrawn from station C1 and transported back to the laboratory along with samples of the industrial dischargers effluent. Toxicity tests with laboratory reared daphnia were conducted in simulated downstream river water and in laboratory water after climatizing the test organisms in each. Simulated downstream water is site water prepared by mixing effluent and upstream water in the same ratio as actually occurs in the waterbody. Lead and zinc were added separately to both and simulated downstream river water and the laboratory water. Testing is done for zinc in one set of tests and for lead in another set of tests. Separate analyses were performed for each metal. For each metal, a 48-hour static acute toxicity test with measured toxicant concentrations in a laboratory beaker was conducted with laboratory reared daphnia on three separate occasions. Similarly, 96-hour flow through acute toxicity tests with measured concentrations of toxicants were also conducted.

In the study with rainbow trout, lead and zinc concentrations were measured respectively in the test waters at the beginning of the test, after 48 hours, and at 96 hours. LC50 values were calculated based on concentrations at the end of the test. LC50 is defined as the concentration of material that is lethal to 50% of the test organisms over the specific time of observation. Analyses of effluent samples from the company's waste treatment system indicates that lead and zinc were present at expected concentrations. In the various dilutions tested, the addition of metal salts to the simulated downstream and laboratory water were at concentrations less than, equal to, or greater than EPA and State acute and chronic water quality criteria under design low flow conditions.

In terms of the toxicity testing, static bioassays were conducted exposing daphnia to zinc and lead. Based upon measured concentrations, the 48-hour LC50 values were determined for simulated downstream river water and for laboratory water, each spiked with either lead or zinc. Flow through bioassays with either zinc or lead were also conducted for rainbow trout. Assuming for this example, that at the times of sample collection the streamflow was sufficiently close to design flow, a geometric mean of the data for daphnia was taken. Results of this procedure show these findings: from this data, it appears that zinc and lead as less toxic in river water than in laboratory water.

Next, we want to perform the calculations of water-effect ratios. In 1994 EPA issued the *Interim Guidance on Determination and Use of Water-Effect Ratios for Metals*. EPA's current recommended procedure for determining water-effect ratios for metals is based on the calculation of a water-effect ratio for a primary species, which in this example is daphnia. The water effect-ratio determines a correction factor to quantify the difference between the toxicity of a pollutant in site water as compared with laboratory or reference water.

The water-effect ratio for acute criteria for a given toxicant is defined as the pollutant concentration at the LC50 value in the stream water, effluent mixture, or other appropriate endpoints such as the EC50 value divided by the pollutant concentration at the corresponding test endpoint value in laboratory water. Measured LC50 values for a toxicant should be somewhat different in the site and laboratory dilution waters to calculate a water-effect ratio. Ratios very close to 1 may indicate that there is really no difference.

Results for this study of our river for daphnia include: the zinc water-effect ratio of 2.25, which is calculated as 900 micrograms per liter, divided by 400 micrograms per liter. The lead water-effect ratio was 4.19, which was calculated as 1300 micrograms per liter, divided by 310 micrograms per liter.

Please note that in these examples, the concentrations are expressed as total recoverable metal. The testing could have been done for dissolved metal if the State standards were expressed as dissolved metal. For comparative purposes, the rainbow trout results for zinc were 1.50, and for lead 3.69. The *Interim Guidance on Determination and Use of Water-Effect Ratios for Metals* recommends the use of a test organism whose sensitivity is equal to or slightly less than the EPA criteria. In this example, daphnia was selected as the primary test species. Less sensitive species like trout generally yield lower water-effect ratios. Thus, the final instream site-specific criteria for zinc and lead are based on daphnia data. However, the trout data, while lower, are similar and thus substantiate that the daphnia data are reasonable.

For zinc, EPA's and the State's acute criterion at 50 milligrams per liter of hardness, is 65 micrograms per liter. This is multiplied by the water-effect ratio of 2.25 to yield a site-specific acute criterion of 146.2 micrograms per liter as total recoverable zinc.

To determine the site-specific chronic criterion, we will utilize an approach taken from EPA's Guidelines for Deriving Numeric Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses, published in 1985. The acute criterion is equal to one-half of the final acute value (FAV). The chronic criteria can be determined by dividing the FAV by the final acute to chronic ratio (ACR). Therefore, by multiplying the site-specific acute criterion by 2, we can obtain a site-specific FAV. The site-specific chronic criterion is equal to the site-specific FAV divided by the national final acute to chronic ratio. The site-specific acute criterion for zinc, 146.2, is multiplied by 2 then divided by EPA's national acute to chronic ratio of 2.208, yielding a site-specific chronic criterion of 132.4 micrograms per liter as total recoverable zinc.

Let me also mention that the use of the national acute to chronic ratio is the simplest approach, however, chronic testing for a chronic water-effect ratio could have been performed.

For lead, EPA's and the State's acute criterion at 50 milligrams per liter of hardness is 34 micrograms per liter. This is multiplied by the water-effect ratio of 4.06, yielding a site-specific acute criterion of 138 micrograms per liter as total recoverable lead. The site-specific acute criterion for lead, 138 micrograms per liter is multiplied by 2, then divided by EPA's recommended acute to chronic ratio 51.29, yielding a site-specific chronic criterion of 5.38 micrograms per liter as total recoverable lead.

To convert these instream site-specific criteria to permit limits, generally would proceed without further consideration of chemical partitioning between the total recoverable metal and the biologically available metal. Permit limits are almost always expressed as total recoverable metal, so that no further corrections are required. In some cases, however, it may be necessary empirically evaluate how the total recoverable metal in an effluent changes chemical form upon discharge to a receiving water. Such translation would be required if the site-specific criteria were determined as dissolved criteria. Translation of such dissolved criteria to total recoverable permit limits can be done by acquiring appropriate chemical data during the performance of the toxicity testing. This would be accomplished by analyzing both dissolved and total recoverable metals.

Now let's summarize the study:

> The results of conducting the toxicity tests indicate that this river's water reduces the toxicity of lead and zinc relative to laboratory water. The difference in measured toxicity between laboratory and simulated downstream site water, expressed as the water-effect ratio, was used to calculate a State site-specific criterion by modifying the national or State criteria. The extent to which the river water reduces bio-availability and toxicity can be examined by determining a water-effect ratio. The water-effect ratio of 2.25 was calculated for zinc, and a water-effect ratio of 4.19 was calculated for lead. These results are substantiated by similar toxicity testing of rainbow trout and by analyses of the results of instream biological survey.

Let's look at a list of factors which are important to keep in mind when performing a site-specific study. Each of EPA's recommended procedures are appropriate for particular situations. The indicator species procedure, for example, may be the most appropriate when some aspect of the water's quality affects a pollutant's toxicity. In performing a water-effects ratio study, the test organism should be chosen by examining the site and by using EPA's or the State's database. While not required, it is generally best to use sensitive species in the test, and preferably the species EPA used to calculate the national criteria.

Select the appropriate toxicity testing method or protocol. EPA recommends using it's own protocols or those of the American Society for Testing Materials (ASTM). Other scientifically defensible protocols are acceptable, however.

Determine how much testing will be required and the appropriate period of time that will be required to derive the site-specific criterion. Remember, the toxicity testing phase includes chemical analysis, toxicity testing, data analysis, and water-effect ratio computation, along with QA/QC procedures. Use clean techniques when collecting samples and performing chemical analyses to help minimize contamination of the samples. The work necessary to develop a site-specific criterion may be conducted by a third party, such as an independent laboratory or a consultant. Municipalities, corporations, and other organizations may also do the necessary work. The State must review and analyze data presented by the third party and make a decision on whether to adopt the site-specific criterion. The State-adopted site-specific criterion is then subject to EPA review and approval.

A more complete discussion of development of site-specific criteria using indicator species or water-effect ratio procedures, is contained in the *Interim Guidance on Determination and Use of Water-Effect Ratios for Metals*. It also contains recommendations for clean sampling and analytical procedures.

The development of site-specific criteria is important to the development of State water quality standards because they reflect local environmental conditions that are primarily the result of differences in the indigenous biological community or in water chemistry. Site-specific criteria are not needed in all situations, however. Therefore, it is strongly recommended that any party interested in proposing site-specific criteria should involve the State and the appropriate EPA regional office at the start of the site-specific project. This can facilitate the process by fostering an agreement concerning data needs, sources for generating new data, testing procedures to be followed, and QA/QC procedures.

Additional information about the water quality standards and criteria programs, including technical assistance, can be obtained from EPA Headquarter's Office of Science and Technology, or EPA Regions 1-10.

POTENTIAL CLEAN WATER ACT APPLICATIONS FOR SEDIMENT CRITERIA

Section 104(n)(1)

Section 104(n)(1) authorizes the Administrator to establish national programs that study the effects of pollution in estuaries, including sedimentation, on aquatic life.

Section 304(a)(1)

Section 304(a)(1) directs the Administrator to develop and publish criteria for water quality that accurately reflect the latest scientific knowledge in a wide range of technical areas, including information on the factors affecting rates of organic and inorganic sedimentation for varying types of receiving waters.

— and —

Section 304(a)(2)

Section 304(a)(2) directs the Administrator to develop and publish information on, among other things, "the factors necessary for the protection and propagation of shellfish, fish, and wildlife for classes and categories of receiving waters . . ."

To the extent that sediment criteria can be developed, they could also be used in implementing other sections of the Clean Water Act.

Section 301

When monitoring discharges under section 301, which establishes effluent limitations, the analyzed contaminated sediments could be compared with sediment criteria to determine if any adverse risk is possible or if remediation activities should be considered.

Section 402

Under section 402, the National Pollutant Discharge Elimination System (NPDES) Program could use sediment criteria to assist in modifying discharge restrictions when establishing permit limits to prevent even low levels of permitted chemical discharges from adding to the current sediment contaminant loads.

Section 404

Sediment criteria also could be used to help implement section 404, which regulates the discharge of dredged or fill material *(sediments and debris removed from the bottom of a waterbody by a scooping or suction device)* into waters of the United States, by evaluating sediments proposed for dredging and redisposal at an aquatic disposal site or by evaluating the suitability of a site for disposal of dredged materials *(or the incremental addition of pollutants).*

Additional Clean Water Act Program Applications of Sediment Quality Measures

Relevant Sections	Site Characterization		Contaminant Source Control						Remediation		
	Problem Area Identification	NEPA/ Section 404 Permit Review or Document Preparation	Discharge Permit Decisions	Discharge Siting	Discharge Monitoring	Dump Site Designation	Dump Site Monitoring	Dredged Material Evaluation	Cleanup Area Selection	Cleanup Goal Setting	Site Restoration
101(a)(3)			■		■						
104	■				■				■	■	
115	■							■	■	■	■
117(a)(3)(4)	■			■							
118	■								■	■	
118(c)(3)	■								■	■	
301(h)	■		■		■						
301(b)(1)(c)			■								
303/304	■		■	■	■				■	■	■
305(b)	■										
311			■	■					■	■	■
314	■								■	■	■
320	■			■	■			■	■	■	■
402			■		■						
403(c)			■		■						
404	■	■				■	■	■			

CLASS EXERCISE

The City of Some Place Else in Newlandia (our 51st state) is on the shores of the Lake Tranquil, one of the largest lakes in the country. The Camotop River runs through the city and empties into the lake. The river has historically been used as a commercial fishing port, for fish packing, and for boat maintenance. The city was built prior to controls for stormwater runoff and there are several CSOs discharging to the river. One mile upstream from the mouth of the river is the now-abandoned Never Ready Battery Plant which went out of business 15 years ago.

The bottom of the river is composed of materials ranging from fine silty clay to bedrock. Most of the river bottom is covered with varying thicknesses of silt, clay, sand, or gravel, and some sections are limestone bedrock. The velocity of the currents dictates the bottom constituents; i.e., the backwater and protected areas near the shoreline are dominated by silty clay ooze, and the majority of the moderate velocity areas are fine gravel or medium sand. River sediments continuously shift and change in areas where velocities are moderate to high, resulting in shoaling in the dredged navigation channels and considerable downstream transport od sediment.

Sediments in the Camotop River are heavily polluted by the following contaminants: arsenic, cadmium, chromium, copper, cyanide, iron, lead, manganese, mercury, nickel, zinc, PCBs, and oil and grease.

The city is now faced with the need to address the contaminated sediment issue. Due to shoaling, navigation is being impeded and the fishing vessels are continually resuspending the sediments.

INSTRUCTIONS FOR CLASS EXERCISE

The Blue Group — discuss steps for finding the contaminated sediments and determine how these sediments can be assessed for their impacts on the environment.

The Red Group — come up with recommendations for implementing prevention and source controls to reduce and prevent sediment contamination through permitting and enforcement activities.

The Green Group — develop a framework for determining when, how, and what degree contaminated sediments should be remediated.

The Yellow Group — select appropriate disposal methods for removed contaminated sediments.

SEDIMENT CLASSIFICATION METHODS

Method	Type: Numerical	Type: Descriptive	Type: Combination	Concept
Bulk Sediment Toxicity		■		Test organisms are exposed to sediments that may contain unknown quantities of potentially toxic chemicals. At the end of a specified time period, the response of the test organisms is examined in relation to a specified biological endpoint.
Spiked-Sediment Toxicity	■			Dose-response relationships are established by exposing test organisms to sediments that have been spiked with known amounts of chemicals or mixtures of chemicals.
Interstitial Water Toxicity	■			Toxicity of interstitial water is quantified and specific procedures are applied to identify and quantify chemical components responsible for sediment toxicity. The procedures are implemented in three phases to characterize interstitial water toxicity, identify the suspected toxicant, and confirm toxicant identification.
Equilibrium Partitioning	■			A sediment quality value for a given contaminant is determined by calculating the concentration at which the sediment particles and interstitial water are both at effects concentrations (SQC and SCV). Below this concentration, the chemical will not cause toxic effects; above it, it is expected to cause toxic effects.
Tissue Residue	■			Safe sediment concentrations of specific chemicals are established by determining the sediment chemical concentration that will result in acceptable tissue residues. Methods to derive unacceptable tissue residues are based on chronic water quality criteria and bioconcentration factors, chronic dose-response experiments or field correlations, and human health risk levels from the consumption of freshwater fish or seafood.

Method	Type: Numerical	Type: Descriptive	Type: Combination	Concept
Freshwater Benthic Community Structure		■		Environmental degradation is measured by evaluating alterations in freshwater benthic community structure.
Marine Benthic Community Structure		■		Environmental degradation is measured by evaluating alterations in marine benthic community structure.
Sediment Quality Triad	■	■	■	Sediment chemical contamination, sediment toxicity, and benthic infauna community structure are measured on the same sediment. Correspondence between sediment chemistry, toxicity, and biological effects is used to determine sediment concentrations that discriminate conditions of minimal, uncertain, and major biological effects.
Apparent Effects Threshold	■		■	An AET is the sediment concentration of a contaminant above which statistically significant biological effects (e.g., amphipod mortality in bioassays, depressions in the abundance of benthic infauna) would always be expected. AET values are empirically derived from paired field data for sediment chemistry and a range of biological effects indicators and identifies a correlation between toxic effects and a chemical.
International Joint Commission[a]				Contaminated sediments are assessed in two stages: 1) an initial assessment that is based on macrozoobenthic community structure and concentrations of contaminants in sediments and biological tissues, and 2) a detailed assessment that is based on a phased sampling of the physical, chemical, and biological aspects of the sediment, including laboratory toxicity bioassays.

[a] The IJC approach is an example of a sequential approach, or "strategy" combining a number of methods for the purpose of assessing contaminated sediments in the Great Lakes.

NARRATIVE CRITERIA WITHIN THE AQUATIC LIFE CLASSIFICATION SCHEME FOR MAINE

RIVERS AND STREAMS	MANAGEMENT PERSPECTIVE	NARRATIVE CRITERIA
Class AA	High-quality water for preservation of recreational and ecological interests. No discharges of any kind permitted. No impoundment permitted.	Aquatic life shall be as naturally occurs.
Class A	High-quality water with limited human interference. Discharges restricted to noncontact process water or highly treated wastewater of quality equal to or better than the receiving water. Impoundment allowed.	Aquatic life shall be as naturally occurs.
Class B	Good-quality water. Discharges of well-treated effluents with ample dilution permitted.	Ambient water quality sufficient to support life stages of all indigenous aquatic species. Only nondetrimental changes in community composition may occur.
Class C	Lowest-quality water. Requirements consistent with interim goals of the Federal Water Quality Law (fishable/ swimmable).	Ambient water quality sufficient to support the life stages of all indigenous fish species. Changes in species composition may occur but structure and function of the aquatic community must be maintained.

NARRATIVE CRITERIA EXAMPLE FOR ARKANSAS

Fisheries: Streams: Ozark Highlands Ecoregion

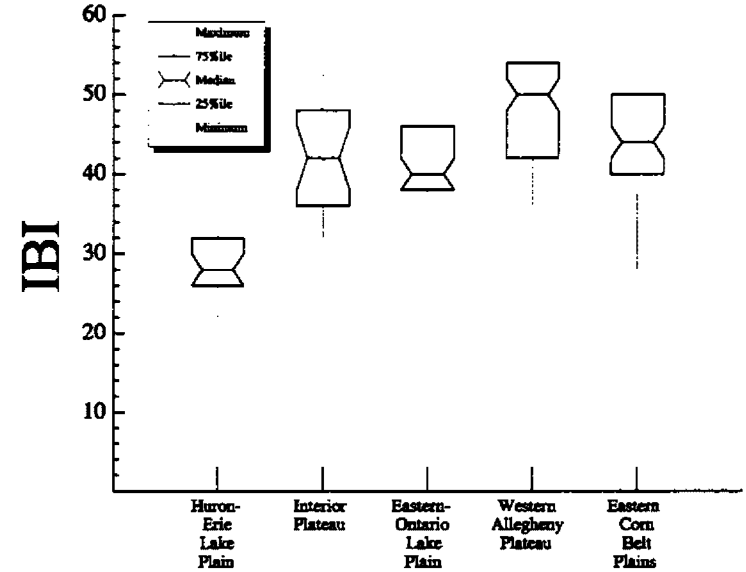
Fisheries - This beneficial use provides for the protection and propagation of fish, shellfish, and other forms of aquatic life. It is further subdivided into the following subcategories:

Streams - Water which is suitable for the protection and propagation of fish and other forms of aquatic life adapted to flowing water systems whether or not the flow is perennial.

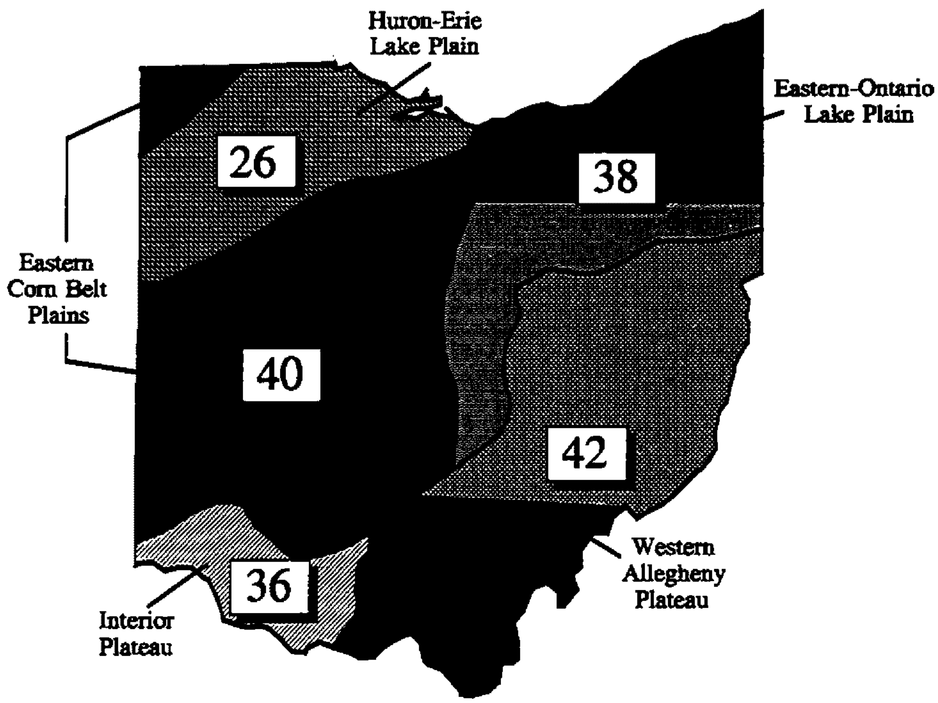
Ozark Highlands Ecoregion - Streams supporting diverse communities of indigenous or adapted species of fish and other forms of aquatic life. Fish communities are characterized by a preponderance of sensitive species and normally dominated by a diverse minnow community followed by sunfishes and darters. The community may be generally characterized by the following fishes:

Key Species	Indicator Species
Duskystripe shiner	Banded sculpin
Northern hogsucker	Ozark madtom
Slender madtom	Southern redbelly dace
"Rock" basses	Whitetail shiner
Rainbow and/or Orangethroat darters	Ozark minnow
Smallmouth bass	

INDEX OF BIOTIC INTEGRITY (IBI)
FIVE OHIO ECOREGIONS

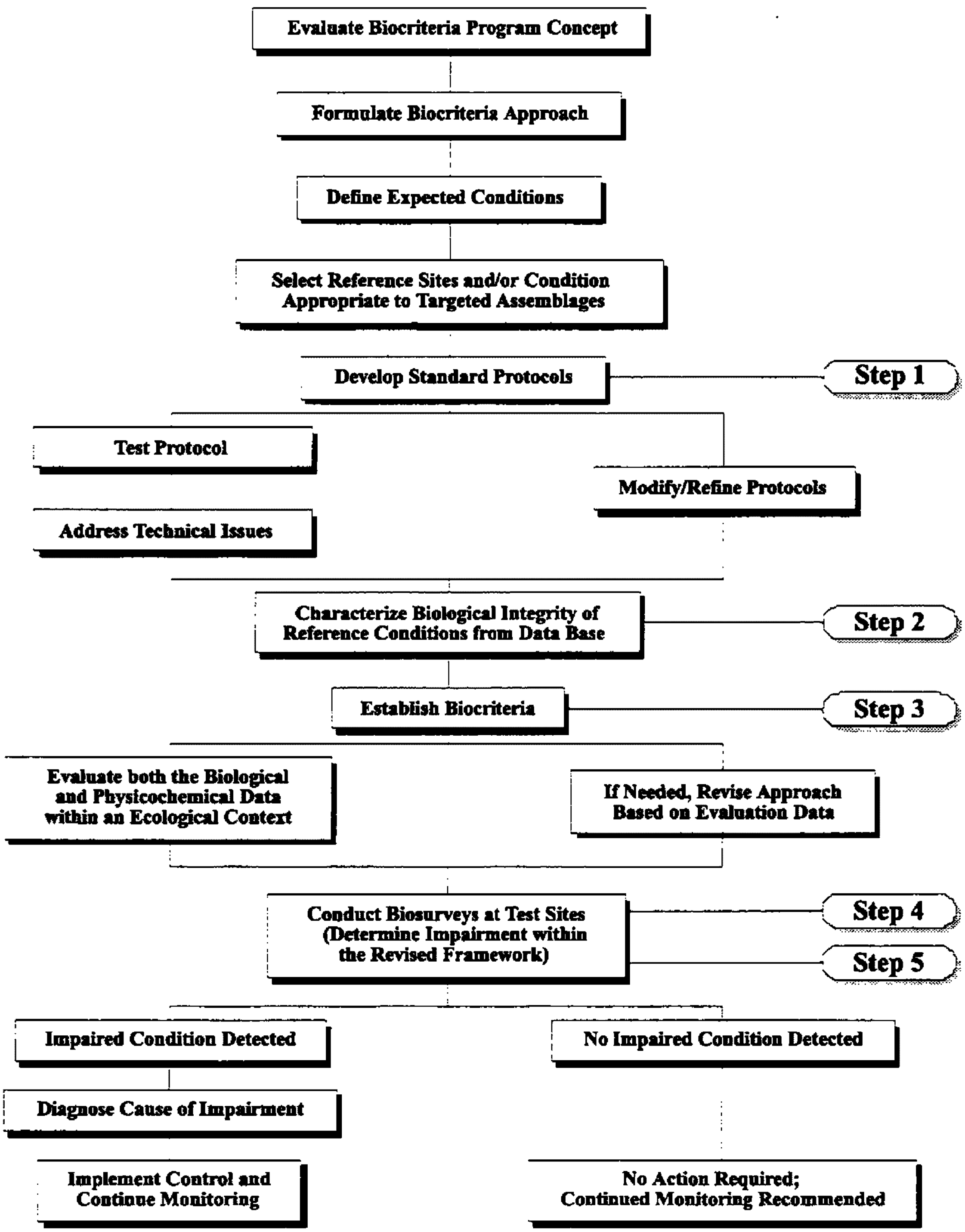


Frequency distribution of Index of Biotic Integrity (IBI) results from individual samples collected at reference sites in each of the five Ohio ecoregions.



Biological criteria (based on 25%ile IBI values) in Ohio WQS for Warmwater Habitat.

PROCESS FOR DEVELOPING AND IMPLEMENTING BIOLOGICAL CRITERIA



HABITAT ASSESSMENT FIELD DATA SHEET
RIFFLE/RUN PREVALENCE

	Category			
Habitat Parameter	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
1. Bottom substrate/ instream cover (a)	Greater than 50% mix of rubble, gravel, submerged logs, undercut banks, or other stable habitat. **16-20**	30-50% mix of rubble, gravel, or other stable habitat. Adequate habitat. **11-15**	10-30% mix of rubble, gravel, or other stable habitat. Habitat availability less than desirable. **6-10**	Less than 10% rubble, gravel, or other stable habitat. Lack of habitat is obvious. **0-5**
2. Embeddedness (b)	Gravel, cobble, and boulder particles are from 0-25% surrounded by fine sediment. **16-20**	Gravel, cobble, and boulder particles are from 25-50% surrounded by fine sediment. **11-15**	Gravel, cobble, and boulder particles are from 50-75% surrounded by fine sediment. **6-10**	Gravel, cobble, and boulder particles are over 75% surrounded by fine sediment. **0-5**
3. ≤0.15 cms (5 cfs)→ Flow at rep. low	Cold >0.05 cms (2 cfs) Warm >0.15 cms (5 cfs) **16-20**	0.03-0.05 cms (1-2 cfs) 0.05-0.15 cms (2-5 cfs) **11-15**	0.01-0.03 cms (0.5-1 cfs) 0.03-0.05 cms (1-cfs) **6-10**	<0.01 cms (0.5 cfs) <0.03 cms (1 cfs) **0-5**
OR				
>0.15 cms (5 cfs)→ velocity/depth	Slow (<0.3 m/s), deep (>0.5 m): slow, shallow (<0.5 m); fast (>0.3 m/s), deep; fast, shallow habitats all present. **16-20**	Only 3 of the 4 habitat categories present (missing riffles or runs receive lower score than missing pools). **11-15**	Only 2 of the 4 habitat categories present (missing riffles or runs receive lower score). **6-10**	Dominated by 1 velocity/depth category (usually pools). **0-5**
4. Canopy cover (shading) (c) (d) (g)	A mixture of conditions where some areas of water surface fully exposed to sunlight, and other receiving various degrees of filtered light. **16-20**	Covered by sparse canopy; entire water surface receiving filtered light. **11-15**	Completely covered by dense canopy; water surface completely shaded OR nearly full sunlight reaching water surface. Shading limited to <3 hours per day. **6-10**	Lack of canopy, full sunlight reaching water surface. **0-5**
5. Channel alteration (a)	Little or no enlargement of islands or point bars, and/or no channelization. **12-15**	Some new increase in bar formation, mostly from coarse gravel; and/or some channelization present. **8-11**	Moderate deposition of new gravel, coarse sand on old and new bars; and/or embankments on both banks. **4-7**	Heavy deposits of fine material, increased bar development; and/or extensive channelization. **0-3**

Habitat Parameter	Category: Optimal	Suboptimal	Marginal	Poor
6. Bottom scouring and deposition (a)	Less than 5% of the bottom affected by scouring and/or deposition. **12-15**	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools. **8-11**	30-50% affected. Deposits and/or scour at obstructions, constrictions, and bends. Filling of pools prevalent. **4-7**	More than 50% of the bottom changing frequently. Pools almost absent due to deposition. Only large rocks in riffle exposed. **0-3**
7. Pool/riffle, run/bend ratio (a) (distance between riffles divided by stream width)	Ratio: 5—7. Variety of habitat. Repeat pattern of sequence relatively frequent. **12-15**	7-15. Infrequent repeat pattern. Variety of macrohabitat less than optimal. **8-11**	15-25. Occasional riffle or bend. Bottom contours provide some habitat. **4-7**	>25. Essentially a straight stream. Generally all flat water or shallow riffle. Poor habitat. **0-3**
8. Lower bank channel capacity (b)	Overbank (lower) flows rare. Lower bank W/D ratio <7. (Channel width divided by depth or height of lower bank.) **12-15**	Overbank (lower) flows occasional. W/D ratio 8-15. **8-11**	Overbank (lower) flows common. W/D ratio 15-25. **4-7**	Peak flows not contained or contained through channelization. W/D ratio >25. **0-3**
9. Upper bank stability (a)	Upper bank stable. No evidence of erosion or bank failure. Side slopes generally <30°. Little potential for future problems. **9-10**	Moderately stable. Infrequent, small areas of erosion mostly healed over. Side slopes up to 40° on one bank. Slight potential in extreme floods. **6-8**	Moderately unstable. Moderate frequency and size of erosional areas. Side slopes up to 60° on some banks. High erosion potential during extreme high flow. **3-5**	Unstable. Many eroded areas. "Raw" areas frequent along straight sections and bends. Side slopes >60° common. **0-2**
10. Bank vegetative protection (d)	Over 90% of the streambank surfaces covered by vegetation. **9-10**	70-89% of the streambank surfaces covered by vegetation. **6-8**	50-79% of the streambank surfaces covered by vegetation. **3-5**	Less than 50% of the streambank surfaces covered by vegetation. **0-2**
OR				
Grazing or other disruptive pressure (b)	Vegetative disruption minimal or not evident. Almost all potential plant biomass at present stage of development remains. **9-10**	Disruption evident but not affecting community vigor. Vegetative use is moderate, and at least one-half of the potential plant biomass remains. **6-8**	Disruption obvious; some patches of bare soil or closely cropped vegetation present. Less than one-half of the potential plant biomass remains. **3-5**	Disruption of streambank vegetation is very high. Vegetation has been removed to 2 inches or less in average stubble height. **0-2**

Habitat Parameter	Category: Optimal	Suboptimal	Marginal	Poor
11. Streamside cover (b)	Dominant vegetation is shrub. **9-10**	Dominant vegetation is of tree form. **6-8**	Dominant vegetation is grass or forbs. **3-5**	Over 50% of the streambank has no vegetation and dominant material is soil, rock, bridge materials, culverts, or mine tailings. **0-2**
12. Riparian vegetative zone width (least buffered side) (e) (f) (g)	>18 meters. **9-10**	Between 12 and 18 meters. **6-8**	Between 6 and 12 meters. **3-5**	<6 meters. **0-2**
Column Totals	____	____	____	____

__________ Score ______

INDEX OF BIOTIC INTEGRITY

The Index of Biotic Integrity (IBI) is commonly used for fish community analysis. The original IBI contains 12 metrics:

6 metrics evaluate species richness and composition:
- number of species
- number of darter species
- number of sucker species
- number of sunfish species
- number of intolerant species
- proportion of green sunfish

3 metrics quantify trophic composition:
- proportion of omnivores
- proportion of insectivorous cyprinids
- proportion of piscivores

3 metrics summarize fish abundance and condition information:
- number of individuals in sample
- proportion of hybrids
- proportion of individuals with disease or anomalies

IBI Metrics Used in Various Regions of North America

Variations in IBI Metrics	Midwest	New England	Ontario	Central Appalachia	Colorado Front Range	Western Oregon	Sacramento-San Joaquin
1. Total Number of Species	X	X		X	X		X
# native fish species			X			X	
# salmonid age classes						X	X
2. Number of Darter Species	X			X	X		
# sculpin species						X	
# benthic insectivore species		X					
# darter and sculpin species			X				
# yearling salmonids (individ.)							
% round-bodied suckers						X	X
# sculpins (individuals)	X						
							X
3. Number of Sunfish Species	X				X		
# cyprinid species						X	
# water column species		X					
# sunfish and trout species			X				
# salmonid species							X
# headwater species	X						
4. Number of Sucker Species	X	X				X	
# adult trout species						X	X
# minnow species	X				X		
# sucker and catfish species			X				
5. Number of Intolerant Species	X	X			X	X	
# sensitive species	X						
# amphibian species							X
presence of brook trout			X				
6. % Green Sunfish	X						
% common carp						X	
% white sucker		X			X		
% tolerant species	X						
% creek chub				X			
% dace species			X				
7. % Omnivores	X	X	X	X	X		
% yearling salmonids					X	X	
8. % Insectivorous Cyprinids	X						
% insectivores		X				X	
% specialized insectivores				X	X		
# juvenile trout							X
% insectivorous species	X						

Variations in IBI Metrics	Midwest	New England	Ontario	Central Appalachia	Colorado Front Range	Western Oregon	Sacramento-San Joaquin
9. % Top Carnivores	X	X	X				
% catchable salmonids						X	
% catchable trout							X
% pioneering species	X						
Density catchable wild trout							X
10. Number of Individuals	X		X	X	X	X	X
density of individuals		X					
11. % Hybrids	X	X					
% introduced species					X	X	
% simple lithophils	X						
# simple lithophilic species	X						
% native species							X
% native wild individuals							X
12. % Individuals with Diseases or Anomalies	X	X	X	X	X	X	

IBI SCORING CRITERIA

Example. Index of Biotic Integrity Metrics and Scoring Criteria based on fish community data from more than 300 reference sites throughout Ohio. These criteria apply to boat sites only.

		Scoring Criteria		
Category	**Metric**	**5**	**3**	**1**
Species composition	Total species	>20	10-20	<10
	% Round-bodied suckers	>38	19-38	<19
	Sunfish species	>3	2-3	<2
	Sucker species	>5	3-5	<3
	Intolerant species	>3	2-3	<2
	% Tolerant (number)	<15	15-27	>27
Trophic composition	% Omnivores	<16	16-28	>28
	% Insectivores	>54	27-54	<27
	% Top carnivores	>10	5-10	<5
Fish condition	% Simple lithophils	>50	25-50	<25
	% Anomalies	<0.5[a]	0.5-3.0[b]	>3.0
	Total fish numbers[c]	>450	450-200	<200

[a]Or >1 individual at sites with <200 total fish.
[b]Or >2 individuals at sites with <200 total fish.
[c]Excludes tolerant species; special scoring procedures are used when relative numbers are less than 200/km.

IBI WORKSHEET

Example. Evaluation of the fish community at two sites in the Upper Hocking River during August-September 1982, using the Index of Biotic Integrity modified for application to Ohio waters (boat sites).

Scores are assigned based on whether the individual metric values (in parentheses) approximate (5), partially deviate (3), or strongly deviate (1) from what is expected in a least impaired stream or river.

	Sampling Station (River Mile)					
	82.4			78.3		
IBI Metrics Sample:	1	2	3	1	2	3
Total Species	(6)___	(5)___	(4)___	(16)___	(14)___	(14)___
% Round-bodied Suckers	(4)___	(0)___	(4)___	(19)___	(32)___	(34)___
Sunfish Species	(2)___	(1)___	(2)___	(4)___	(3)___	(4)___
Sucker Species	(2)___	(1)___	(2)___	(3)___	(5)___	(3)___
Intolerant Species	(0)___	(0)___	(0)___	(0)___	(0)___	(0)___
% Tolerant (number)	(85)___	(86)___	(92)___	(60)___	(44)___	(42)___
% Omnivores	(70)___	(67)___	(76)___	(53)___	(41)___	(38)___
% Insectivores	(22)___	(19)___	(20)___	(36)___	(54)___	(50)___
% Top Carnivores	(7)___	(7)___	(4)___	(5)___	(4)___	(10)___
% Simple Lithophils	(22)___	(7)___	(8)___	(60)___	(72)___	(57)___
% Anomalies	(10)___	(4)___	(5)___	(0.2)___	(0.4)___	(0.2)___
Total Fish Numbers (Individuals)	(8)___	(12)___	(4)___	(87)___	(106)___	(130)___
Index Value						

VIDEO TRANSCRIPT

Development of Biological Criteria

19 minutes, 30 seconds

The principal objectives of the Clean Water Act are to "restore and maintain the chemical, physical, and biological integrity of the nation's waters." Thus, the condition of specific waters—or waterbodies—is determined from the combined measures of physical, . . . chemical, and . . . biological characteristics of each type of waterbody . . .

This presentation provides an overview of the biological criteria that States and Indian Tribes are to adopt to meet the objectives of the Clean Water Act. More specifically, I will be discussing biological criteria as they relate to the water quality standards program.

States adopt biological criteria into their water quality standards, which are subject to EPA review and approval under the Clean Water Act. When I refer to States, I am also referring to Indian Tribes because Indian Tribes may qualify for treatment as States in the water quality standards program.

. . . Let's begin with some background.

Water quality standards are laws or regulations which consist of the designated use or uses of a waterbody or segment of a waterbody, and the water quality criteria necessary to protect the designated use or uses of that waterbody. Examples of uses are public water supplies, propagation of fish and wildlife, recreational purposes, agriculture, industrial uses, navigation, and other such uses.

Criteria are limits—or carefully defined guidelines—on a particular pollutant or on the conditions of a waterbody that are designed to protect and support a use. When criteria are met, water quality is at a level to protect designated uses. Water quality standards also contain an antidegradation policy and a method for implementing it. The antidegradation policy sets minimum requirements which conserve, maintain, and protect existing uses and water quality.

As I mentioned, the objective of the Clean Water Act is to preserve the chemical, physical, and biological integrity of the nation's waters. Chemical and physical characteristics have long been used to measure water quality. However, as we learned more about aquatic life, it became apparent that biological evaluations were also of great importance.

Biological criteria, or biocriteria (as they are usually called), are based on direct measures of the biological integrity of surface waters . . . and thus they provide a valuable assessment tool for evaluating the quality of our nation's waters. Biocriteria augment, but do not replace, the chemical and physical elements of water quality programs.

A primary strength of biological criteria is that they detect water quality problems that other methods may miss or underestimate. Procedures for developing biological criteria apply to all waterbodies, including rivers, streams, lakes, wetlands, estuaries, and coastal waters. Biocriteria are expressed in terms of "narrative" statements or as "numeric" values that describe the biological condition of aquatic communities that live in waters of a given "use" category. Narrative biocriteria are general statements of attainable conditions such as fish communities as naturally occur. Such a statement may be further refined by lists of species one expects to find in a particular body of water. In the case of a mountain stream, the list may include "trout, sunfish and minnows." Numeric biocriteria (as the name implies) are specific quantitative indicators of a condition of a waterbody.

Numeric biocriteria may be measures of "community structure," such as the number of species in the aquatic community, or they may be measures of "community function," such as nutrient cycling or the presence of different feeding mechanisms, for example, filter feeding, leaf shredding, and predation.

Now that you know more about what biocriteria are, and about the role they play, it's time to talk about how they are developed and implemented.

As we consider the development and implementation of biocriteria for use in water quality standards, we find that five major steps are required. The first step is to apply standard protocols. The second step is to establish reference conditions. The third step is to establish biocriteria. The fourth step is to conduct a site survey, and the fifth step is to analyze data for impact.

Now, let's take a closer look, starting with step 1. A protocol would include the detailed instructions and procedures to be used to obtain information on the aquatic life in the waterbody. This protocol also ensures a consistent method of data collection to provide that information. Basically, to standardize the protocols, each State should validate proposed protocols through pilot studies. These pilot studies help to ensure that the protocols for the biocriteria program will provide reliable measures of the biological condition of the surface waters of the State, test for impacts on waterbodies, and determine any impairment of waterbodies. To assure that the results are scientifically sound, it is essential that each step employs reliable, standardized methods for measuring and comparing the biological status and integrity of any given waterbody.

The next step is to establish reference conditions. This is an important step because establishing reference conditions helps to set the biological condition that can be expected for the waterbody that is to be evaluated. In most cases, the reference condition will be based on a site (or sites) that are the least impacted or disturbed—and that is the closest to a pristine condition that can be found within that ecological region. If one is to evaluate a small stream, the reference site should be another stream of the same size and with similar characteristics. Similarly, if one is to evaluate a lake, the reference site should be a lake of comparable geographic origin and in a natural or minimally developed condition. Thus, the reference site establishes the unimpaired baseline for comparison with the site to be evaluated (which is often referred to as the "subject waterbody").

The methods that are used to characterize the reference condition will be the foundation of the biocriteria that are to be established, and they will be used to evaluate the subject waterbody for the purpose of making a determination of whether the attainment of a designated "use" has been achieved. By designated "use" I mean the type or quality of the fishery or aquatic life "use" to be protected. Examples of two designated uses are a cold water stream that supports trout or a warm water lake that supports bass.

Now, with the standard protocols developed and reference sites established, the next step is to establish the biocriteria. Biocriteria are established by applying the standard protocols to the appropriate reference sites for each type of aquatic life "use" designation and waterbody. The results of the biological surveys of the reference sites are evaluated, and are used to set quantifiable measures of the reference conditions. They are the standard by which the subject waterbody is evaluated. These measures of the reference conditions constitute the primary element of the biocriteria, but are not the only basis for the biocriteria for the type of use designated for the subject waterbody. States may decide to improve the subject waterbody beyond the present condition of the reference site.

So, after the biocriteria have been set, the State or Indian Tribe conducts a site survey of the subject waterbody for subsequent comparison with the appropriate biocriteria that have been established in Step 3. To do this, a habitat evaluation must also be conducted to determine whether the physical environment at the subject waterbody sampling site is comparable to that of the reference site from which the biocriteria were derived. Assuming that the habitats match, a biological site survey is conducted to determine whether the biological integrity of the subject waterbody is consistent with the biocriteria. Keep in mind that the survey of the subject site must use the same biosurvey procedures and protocols that were used at the reference site.

The final step in developing and implementing biocriteria is to analyze data for an impact to the subject waterbody by comparing the data from the biological survey of the subject site with the established biocriteria. This final step requires the use of appropriate statistical or modeling approaches to determine the impairment of the subject waterbody in terms of the attainment or nonattainment of the designated aquatic life use.

So, to summarize this point, there are the 5 basic steps in developing biocriteria as a part of the State's water quality standards program. To support the quality and reliability of the biocriteria process, we must also take into consideration three very important activities. The first is the selection and evaluation of reference sites to support development of biological criteria. The second is the proper measurement of the structure and function of the aquatic community at reference and subject sites of comparable habitats, and the third is the analysis of the results of the biological survey of the subject waterbody to determine impact and to determine attainment or nonattainment of a designated use.

Let's explore them in more detail, one at a time. In selecting and evaluating reference sites, keep in mind that reference conditions should embody the characteristics of waterbody segments that are the least impaired by human activities, and should represent the attainable biological conditions required by the aquatic use the State or Indian Tribe wishes to protect.

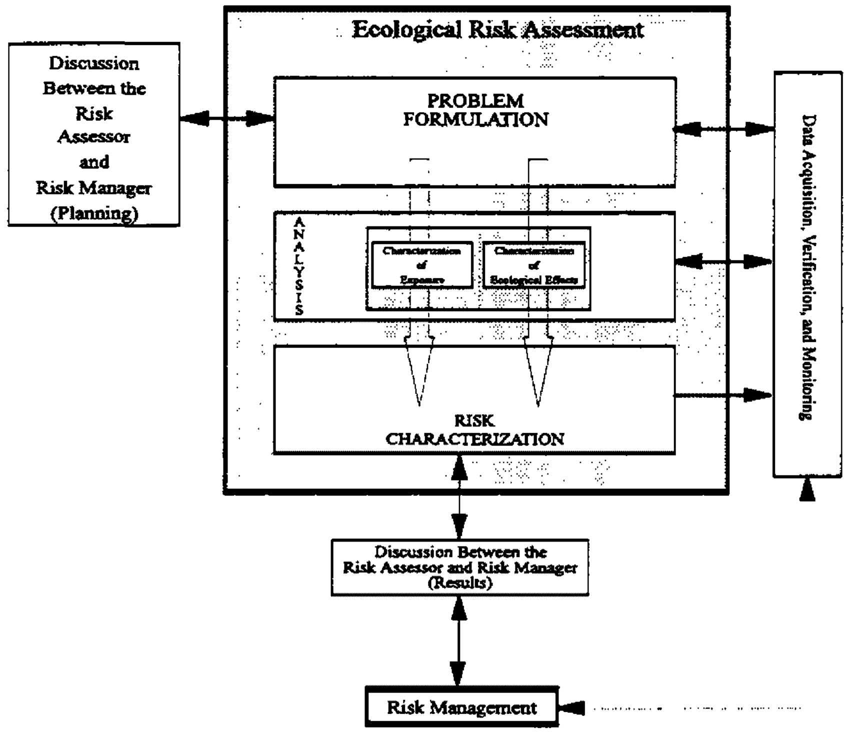
There are two main approaches to establishing a reference condition. One is to use site-specific reference sites within the same waterbody. This is the case, for example, when an upstream site is used as a reference for a downstream subject location or when a nearby undeveloped coastal area is compared to a similar subject site. Site-specific references are useful in controversial situations. However, the site-specific reference approach may be too expensive if used routinely for every site evaluated, and it may prove to be unsatisfactory with multiple discharges such as sewer pipes and nonpoint sources such as runoff from large land areas. Therefore, EPA also recommends the adoption of a second approach, the use of a regional reference site or sites. These ecologically similar regional references form an excellent basis for comparison of many waterbodies. As with site-specific references, the process of selecting and evaluating regional references must be well planned to meet scientific requirements, to maximize information, and to minimize cost.

The U.S. EPA is currently helping States in these efforts. EPA consults with States and assists each State as it designs regional or ecoregional data bases to fit the State's particular needs. Of course, the effective characterization of the biological reference condition must include the actual measurement of the structure and function of the selected aquatic community. The design must incorporate data collection protocols that ensure the optimal characterization of the component that best represents the State's surface waters. In biological surveys, data collection protocols should incorporate the spatial and temporal scales that are responsible for much of the natural variability of aquatic systems. For example, samples taken before and after the seasonal emergence of aquatic insects cannot be directly compared. Many measures of the community structure and function can be used to describe the components of choice. An evaluation of the number of species is the simplest. However, EPA recommends a multiple-measure approach. Examples include the Rapid Bioassessment Protocols developed by EPA. Integrated measures such as these can be used to help set the actual biocriteria for incorporation into State water quality standards.

The third activity is the analysis of the results. Proper analysis of the findings is as important as using the appropriate evaluation methods and techniques. A complete discussion of the analysis process is beyond the scope of this presentation. Nevertheless, let me say again that use of biocriteria in water quality standards requires careful application of established scientific principles, methods, and statistical tools. When impairment of the designated use is found, the next step is to make a diagnosis of the probable cause. Obvious cases, such as point source discharges, are generally readily identifiable, but keep in mind that there may be other sources contributing to the impairment, such as nonpoint sources. In cases where no obvious cases are observed, the diagnostic procedure becomes a repeated process of investigating and testing until the causes are determined.

Now let's review. The development of biological criteria adds another dimension to physical and chemical criteria for a more integrated assessment of water quality. Biological assessments, when used in conjunction with traditional methods, will give a better assessment of the overall ecological integrity of the subject water. Narrative and numeric biological criteria are statements of the condition of aquatic biota that are attainable in order to meet a designated use or uses. A reference condition must be selected that is representative of the least disturbed waterbodies for each designated use. Biological surveys of subject waterbodies and of reference waterbodies must be conducted in a standardized fashion, so that ecologically relevant and statistically rigorous conclusions are drawn. A finding of waterbody impairment based on biocriteria must be confirmed by testing whether the habitats of the reference and subject sites are, indeed, the same. And, when findings and analyses show that a designated use has not been attained, a process of diagnosis of the cause of the impairment is to be undertaken. Biocriteria are an important addition to a State's water quality management program. This will become increasingly apparent as more States incorporate biocriteria into their water quality standards. The EPA develops technical guidance and other information to assist the States in meeting the requirements of the water quality standards program. These informational materials are augmented by technical assistance workshops and individual consultations. Additional information about the water quality standards program may be obtained from this address and from the following EPA locations . . .

ECOLOGICAL RISK ASSESSMENT FRAMEWORK



Source: Framework for Ecological Risk Assessment. USEPA Risk Assessment Forum. 1992

CASE STUDY - MODULE 12

This case is based upon a hypothetical example.

Location and Watershed Description

The Dan River lies in the Appalachian region of the southeastern United States. The watershed and its tributaries cover about 1500 square miles of varying terrain characterized by mountain ridges interspersed with broad floodplain valleys with rich soils. The Dan River is part of the headwater system of the Mattapan River that flows to the Atlantic (see map 1). Average precipitation in the Dan River watershed is about 35 inches annually, falling mostly as rain—since snow is infrequent, except in the highest elevations.

The Dan River watershed is comprised of a mosaic of forested lands, agricultural croplands, and grazing lands. The forests are owned privately, and by the state and Federal governments and are dominated by mixed pine as well as ridgeline hardwoods. Dan's Mountain National Forest, with its granite outcroppings, is highly valued by hikers and birdwatchers.

The watershed has two medium sized towns (each ~25,000 people). The towns, East Bend and Little Falls are the sites of local commerce and employment as well as the location of the area's two biggest manufacturing plants. The H&T Paper Company has been making paper at Little Falls since 1890 and the Statesman Furniture Company has been milling wood for furniture and hardwood floors since 1855. Both companies derive all their wood from forests in the region. They are the major sites of non-agricultural employment in the region.

Crop agriculture is second only to timber and pulp industry in economic importance to the area. Agricultural production in the area focuses on soy bean, corn, lima bean, sweet potato and tobacco. The dairy industry, made up primarily of small family farms, is now shrinking because of competition from "agro-conglomerates" from outside of the state.

Historically, coal has been extracted from the portions of the Allegheny Plateau in the westernmost part of the watershed using shaft mines. Limited metal ores were found in the Ridge, in the eastern downstream portion of the watershed and were removed long ago using open pit mines. Mining activities in the area ceased 25 years ago.

Drinking water for the municipalities is surface water from the Dan River. Each municipality operates a water treatment facility for treatment of waste water. Treated waste water is discharged into the river at each facility. In addition, the paper mill discharges effluent to the river.

The Ecological Setting

- Much of the bottomland and urban centers have been intensively managed or developed for over 200 years, but ridgeline forests and steep slopes in the mountainous areas remain isolated and provide habitat and connecting corridors for wildlife.

- The ridgeline is habitat for several endemic (native) plant species and one species of squirrel that is listed as endangered.

- Nesting perigrine falcons depend on both the ridgelines and rock outcroppings for nest sites and upon the availability of songbirds in the valley fields and forests as prey.

- The Dan River below the dam contains refugia for remnants of yellow perch. Striped bass have colonized the lake and are becoming recreationally important. American shad were and important resource historically but no longer occur above the dam and spawning runs are now only a small remnant. Tributaries above the dam support several coldwater fish species, including native brook trout and European brown trout, that are important recreationally. Tributaries are habitat for the endangered Dan River Darter and the Mattapan Madtom.

Nature of the Issues

Industrial, agricultural, forest products development, and the activities of the human population have had a major effect on the ecology of the Dan River Valley over the last 200 years. Clearing of the land for tillable agriculture, dwellings, and other buildings have altered habitat excluding many species or significantly reducing their range and population size. Manufacturing of natural products have historically and continue to produce air and water effluents.

In each of the two communities within the watershed, publically owned treatment works (POTWs) also discharge effluents to the river. In some instances, habitat for aquatic species has been altered physically as well—a mill dam at the pulp and paper plant constructed in 1890 blocked the stream as a migration route for anadromous trout, American shad, Blueback herring, and yellow perch. The same dam obliterated downstream riffles, rapids, and pools that were important to these species and other non-migratory fish. The re-establishment of these important recreational species is a priority of the State Fish and Game Office.

Runoff from tilled land and clear-cut forest has been a significant source of sediment loading to the stream and clearing of the riparian vegetation as part of agricultural practice has resulted in the loss of shading to the river and its tributaries. The result has been a warmer, slower, more sediment and nutrient-laden stream that is no longer able to support much of the historical flora and fauna. The species that depend on clear, cold, well-oxygenated waters have been replaced to varying extents by species more tolerant of the anthropogenic stresses.

Some Stressor and Source Characteristics

- Several abandoned coal mines dot the western mountainsides resulting in chronic low-level discharges of acidic drainage. Additional atmospheric deposition of metals, including mercury, may be attributable to an incinerator located in another state outside the watershed.

- The prevailing winds carry nitrogen and sulphur byproducts into the watershed from power plants outside the watershed.

- Effluent from the pulp and paper mill contains traces of dioxin, fine particulates, organic loading and color.

- Effluents from the furniture mill are primarily air emissions. The air emissions include dust and particulates from furniture sanding and milling as well as volatile organic compounds (VOCs) that evaporate from staining and finishing operations. These compounds include organic materials from stains and wood sealers. There is some evidence that spills or leakage may have occurred from storage tanks out in the mill yard. These tanks contain solvents such as turpentine, stains, and finishes such as polyurathane.

- Continued logging of slope and ridgetop forests would have significant effects on remaining migratory and resident species as well as riparian corridors for species that nest elsewhere.

- Dairy cattle use of riparian corridors along the Dan River and several of its tributaries contributes to the sediment, nutrient and fecal coliform loading to the river and ambient water temperature elevation.

Current Regulatory Activities

- An EPA Region 12 official is reviewing the EPA-issued water quality permit associated with the pulp mill located in the Dan River Watershed. She must also consider whether consultation with the U.S. Fish and Wildlife Service is necessary due to potential impacts to threatened and endangered species from the effluent permitted.

  - The amount of effluent allowed under the pulp and paper mill permits will determine the plants' production capacities and associated forest product demand by the mills.

  - The permits must be written and signed within 6 months to comply with a court order; the court order was the result of a suit filed by the state which cited delays in EPA processing of effluent permits—EPA admits to backlogs due to staff shortages.

- The Department of the Environment in the state is reviewing an air quality permit for the Statesmen Furniture Company.

- The Federal Energy Regulatory Commission (FERC) license for the dam at H&T Paper is up for renewal in two years. Currently, the Dam is used by the mill to generate a small amount of electricity, and a municipal water reservoir for Little Falls.

- East Bend is developing an industrial park to attract employers, and is requesting to double its withdrawal of drinking water from the Dan River, as well as an increase in effluent.

Stakeholders and Their Interests

- EPA Region 12 Division of Water
(See Current Regulatory Activities)

- U.S. Fish and Wildlife Dan River Field Office

  The FWS is interested in protecting the endangered southern squirrel and is considering listing several species of songbirds which nest in the bottomland forest along the Dan River. They are also concerned about the recent decline of perigrine falcons.

- State Fish and Game Little Falls Field Office

  The State Fish and Game is interested in maintaining the recreational fisheries in the Dan River below the dam including white and yellow perch, catfish, and striped bass populations. Increases in temperature, sedimentation, and pollution from air and water emissions have all adversely affected the fisheries.

- State Department of the Environment
(See Current Regulatory Activities)

  The Natural Heritage Office within the Department of the Environment in the state is developing protection programs for rare, endangered, threatened, and other endemic plant species. They are in the process of acquiring riparian land containing bottomland hardwoods to designate as State Preserves.

- U.S. Department of Agriculture Extension Office

  The Extension Office is working with farmers to decrease nonpoint sources of pollution.

- U.S. Department of Agriculture Forest Service

  The Forest Service is interested in protecting the Dan's Mountain National Forest ecosystem and is considering developing an ecosystem management plan for the forest.

- Federal Energy and Regulatory Commission
(See Current Regulatory Activities)

- Save Dan's Mountain Coalition

  The mission of the coalition is to provide for nonconsumptive wildlife viewing, hiking, and research in the Dan's Mountain area. They are concerned about the recent declines in perigrine falcon populations.

- H&T Paper Company

  H&T Paper Company is interested in a continued supply of wood from the forests in the watershed and in the re-issuance of its water discharge permit without any expenditures in new equipment to reduce discharges of metals.

- University of the Southeast, Department of Biology

  The USE Department of Biology has been studying the ecology of both the terrestrial and aquatic ecosystems for years.

- Dan River County Commissioners

  The commissioners are interested in addressing problems with the changing economy of the area.

  The Commission is comprised of the president of the Dan's River Chapter of Ducks Unlimited; plant manager of H&T Paper; Charles Griffen of Griffen Logging; a dairy farmer; a developer from East Bend; and a retired city worker from Little Falls.

- Charles Griffen, owner, Griffen Logging

  Mr. Griffen owns much of the private land in the Dan's Mountain National Forest and would like to continue logging in these areas.

- Statesman Furniture Company

  Statesman is very concerned about the renewal of their air emission permit and is considering ways of reducing pollution that do not involve high costs.

- State Timber and Forestry Office

The State Timber and Forestry Office is interested in maintaining the flow of revenue from logging leases but, is under pressure by local groups to work with other agencies to address the natural resource problems of the area.

Statistical Requirements or Agreements

- The Region 12 water permitting program and nonpoint source grants are administered by EPA under authority of the Clean Water Act; the watershed is located in a non-delegated state, meaning that EPA is responsible directly for all permit writing.

- The air permits associated with the off-watershed incinerator are issued by a delegated state in the region.

- The U.S. Fish and Wildlife Service (FWS), a branch of the Department of Interior, is the Federal agency responsible for administering the Endangered Species Act (ESA) of 1973 for most species. EPA must consult, either formally or informally, with the FWS if EPA determines that its action may affect a threatened or endangered (listed) species or its designated critical habitat. These EPA actions could include registration of a pesticide and any other decision authorized, funded, or implemented by EPA. Also, EPA must confer with the FWS if its action could affect a species or critical habitat that may be proposed for listing. If EPA determines that there will be no effect, consultation is not necessary.

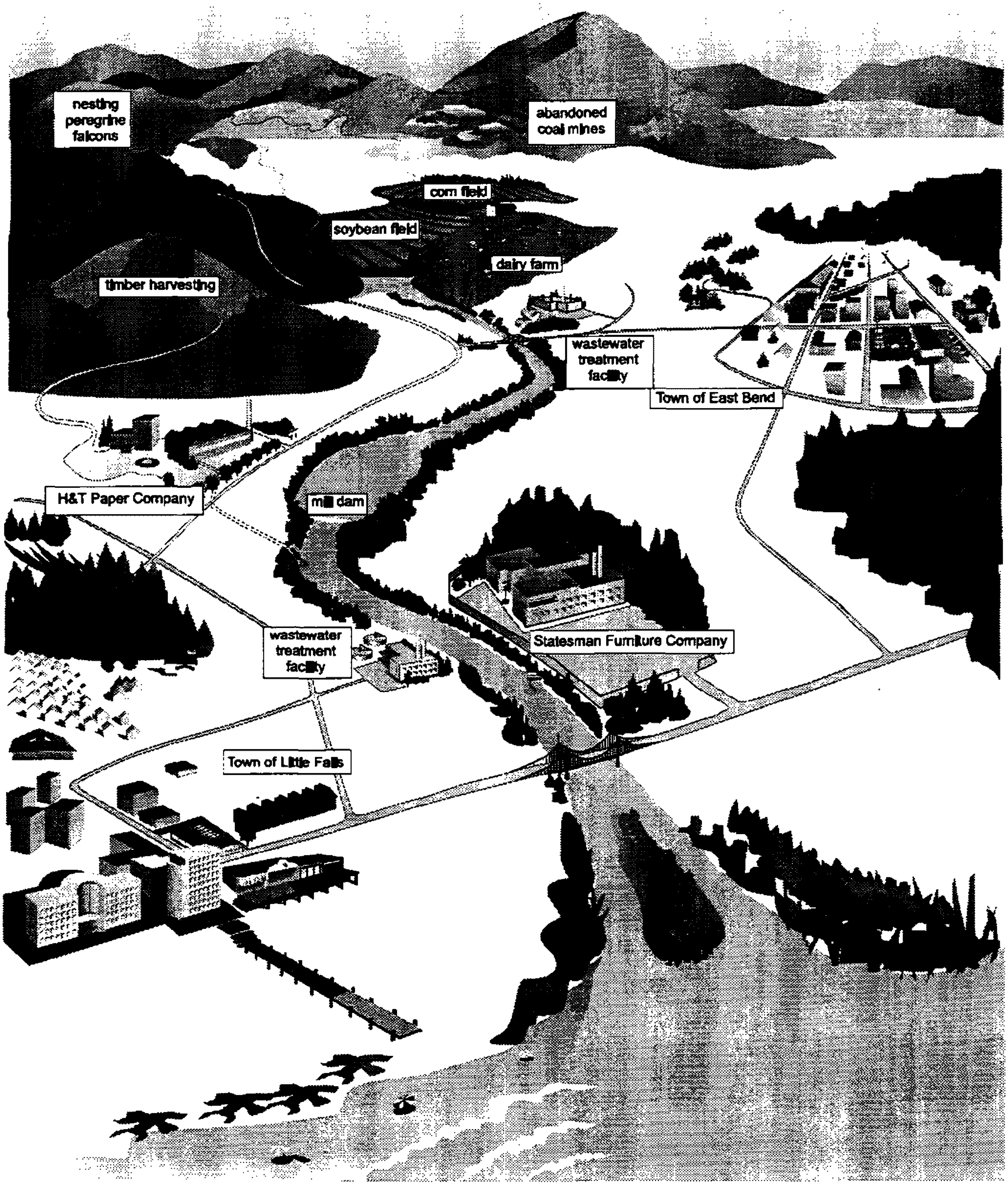
- The Migratory Bird Act, protecting migratory species, and administered by FWS.

- The FERC has authority to issue permits for dams.

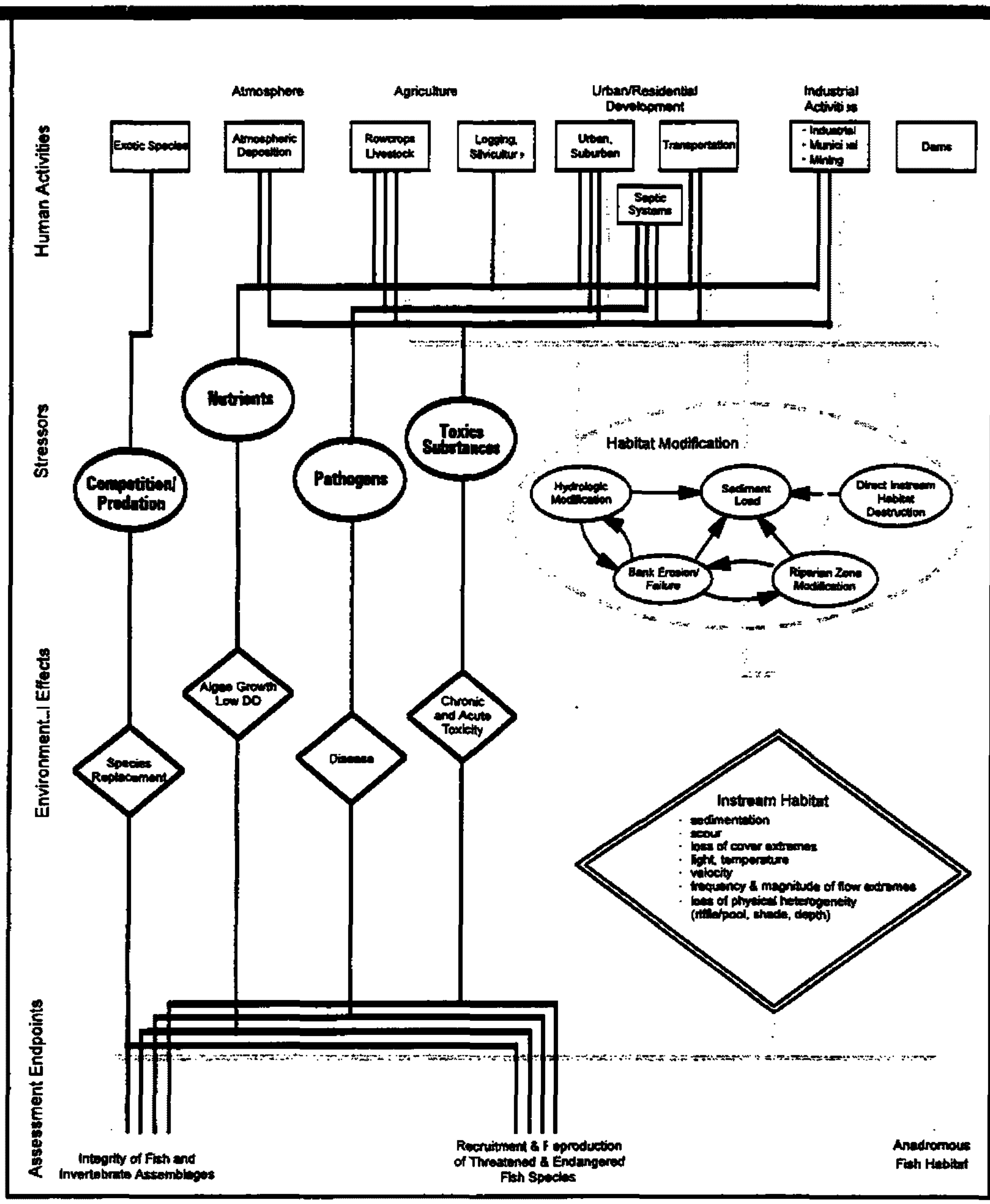
- The Dan River County Development Plan: stresses the continued stable economy supported by the widest range of economic inputs (e.g., farming, mining, forestry) while accommodating a long-term vision of quality public use and recreation on county lands.

- The U.S. Forest Management Act, which specifies timber management on federal forest lands and requires the maintenance of viable populations of native flora and fauna, while allowing for managed timber production. The Federal forest lands are managed by the U.S. Forest Service.

- State Timber and Forestry Office - permits and regulates logging, sales and shipment of timber harvested from private forest land leases.


nesting peregrine falcons
abandoned coal mines
corn field
soybean field
dairy farm
timber harvesting
wastewater treatment facility
Town of East Bend
H&T Paper Company
mill dam
Statesman Furniture Company
wastewater treatment facility
Town of Little Falls

DAN RIVER WATERSHED CONCEPTUAL MODEL



HILL'S CRITERIA FOR EVALUATING CAUSAL ASSOCIATIONS

1. **Strength**: A high magnitude of effect is associated with exposure to the stressor.
2. **Consistency**: The association is repeatedly observed under different circumstances.
3. **Specificity**: The effect is diagnostic of a stressor.
4. **Temporality**: The stressor precedes the effect in time.
5. **Presence of a biological gradient**: A positive correlation exists between the stressor and response.
6. **A plausible mechanism of action.**
7. **Coherence**: The hypothesis does not conflict with knowledge of natural history and biology.
8. **Experimental evidence.**
9. **Analogy**: Similar stressors cause similar responses.

Not all of these criteria must be satisfied, but each incrementally reinforces the argument for causality. Negative evidence does not rule out a causal association but may indicate incomplete knowledge of the relationship (Rothman, 1986).

Hill, A.B. 1965. The environment or disease: Association or causation? *Proceedings of the Royal Society of Medicine* 58:295-300.

Rothman, K.J. 1986. *Modern Epidemiology.* 1st ed. Little, Brown and Company, Boston, MA.

GROUP EXERCISE: DESIGN A RISK COMMUNICATION STRATEGY

You live in the 51st State of the United States of America, Newlandia, which has a population of 2 million. This State is known for its natural beauty and abundant natural resources. Most of its many lakes and rivers have been designated by the State as "fishable/swimmable." The State has also designated several waterbodies as "Outstanding National Resource Waters" (ONRWs). Outstanding National Resource Waters include high-quality or ecologically unique waters such as those within state and national parks and wildlife refuges. Recreational tourism is an important industry in this State. Many people come to Newlandia to hike, fish, swim, and camp.

One industrial pollutant found in many Newlandia surface waters is difestylonium (DFS). DFS is a man-made chemical found in the effluent of the arconalt industry, one of the primary industries and employers in Newlandia and neighboring states.

DFS is regulated under Newlandia's water quality standards (WQS) program. The current WQS includes an ambient water quality criterion (AWQC) for human health based on EPA's 304(a) guidance criterion. The EPA ambient water quality criteria document states that DFS appears to have immune system effects at relatively high levels of exposure; however, it is not clear whether these effects have an adverse impact on human health. DFS is a carcinogen in animal studies where the chemical was administered orally. Fairly high doses of the chemical are required to cause cancer in test animals. There are no human data regarding the carcinogenicity of DFS. The chemical has been classified as a B2 carcinogen (i.e., a probable human carcinogen) based on animal data for oral ingestion.

EPA's AWQC is based on the animal carcinogenicity data. The State has essentially adopted the Federal AWQC. This criterion assumes daily consumption of 2 liters of untreated surface water and 6.5 grams of fish from the surface water. The State chose to adopt into its WQS a 10^{-5} incremental risk level. In other words, exposure to waters containing DFS at the Newlandia standard (3 µg/L) might increase the incidence of cancer by 1 in an exposed population of 100,000.

(The state DFS criteria for aquatic life are higher than the human health criterion, so aquatic life in Newlandia is presumed to be protected by application of the human health criterion where both are applicable [e.g., for water designated as fishable, swimmable, etc.]).

As you learned earlier, water quality standards must be reviewed every 3 years and revised as necessary to meet the goals of the Clean Water Act. The DFS criterion for protection of human health is up for review. You are part of a team for review of the DFS criterion. This team consists mostly of members of the Newlandia WQS program. It also includes EPA's Regional WQS Coordinator, who was invited to participate by the Newlandia Water Quality Agency. This team has held informal meetings with the three parties that have a stake in the standard: the Newlandia Arconalt Industry Federation (NAIF), the Newlandia Environmental Group (NEG), and the Newlandia Tourism Association (NTA).

- Newlandia Arconalt Industry Federation (NAIF). The NAIF does not want the criterion lowered. Members of the organization claim that the pollution control necessary to meet National Pollutant Discharge Elimination System (NPDES) permit limits is already expensive, and any further controls would impose an undue financial burden that would effectively put their members at a competitive disadvantage with other arconalt plants in neighboring states. A more stringent criterion, they argue, would likely threaten the viability of the State's entire arconalt industry.

  The industry performed a cost-benefit analysis in which they analyzed the pollution prevention and control costs as compared to the regulatory benefits in terms of number of cancer cases avoided. They divided the costs of regulatory compliance by the benefits of regulatory compliance (i.e., total number of cancer cases avoided). They claim that compliance with the current DFS standard set at a 10^{-5} risk level (i.e., exposure to waters containing DFS at the current Newlandia standard might cause one additional cancer case in an exposed population of 100,000) now costs the industry $350,000/cancer case avoided. They project that compliance with a more stringent DFS standard set at a 10^{-6} risk level (i.e., exposure to waters containing DFS at that standard would be expected to cause one additional case of cancer in an exposed population of 1 million) would cost the industry $3.5 million/cancer case avoided. Because of the competitive disadvantage this type of criterion would cause, the industry estimates 20,000 jobs would be lost if the DFS criterion were set at the 10^{-6} level.

- Newlandia Environmental Group (NEG). The NEG is the primary watchdog environmental group in the State. It wants to ensure that the standard does not become less stringent.

- Newlandia Tourism Association (NTA). The NTA is primarily concerned with image. This group wants to make sure that, whatever the outcome, the State is still perceived as having high-quality surface water and a strong game fisheries resource. The NTA fears that lowering the DFS criterion might result in more impaired waterbodies and the likelihood of additional fish consumption advisories.

After three informal meetings, all groups agree that the current standard should be maintained. The public hearing for revision of the standard has been scheduled for one week from today. It is important that everything proceed on schedule to meet the EPA deadline for the DFS standard. This deadline has already been postponed once, and the political climate would make it very difficult to postpone this deadline further.

Your team has just received word that the director of the Newlandia Water Quality Agency WQS program, Ms. Staneria, was contacted yesterday afternoon by Mr. Fin, head of the Newlandia Sport Fishermen's Association (NSFA), which has over 100,000 members, some of whom are also professional fishermen. This group has recently discovered, from an article in the *Newland Times* (the most popular newspaper in the State), that the DFS standard is based on an exposure assumption of 6.5 grams (approximately 1/4 ounce) of fish per day. A recent NSFA member survey indicates that NSFA members and their families typically eat about one-half pound of fish per week per person on average—about five times the exposure assumed in the standard. The NSFA is very concerned that the health of its members has been compromised by an underprotective State standard. The organization is also extremely concerned that the proposed standard is not sufficiently protective and will further endanger its members' health.

This morning, Ms. Staneria received a call from Senator Sinker's office in the U.S. Senate. Senator Sinker is chairman of the congressional Wilderness Committee, which is concerned with ensuring protection of wilderness areas. The Senator, an avid fisherman, was contacted by Mr. Fin and is very concerned about the situation. Representatives from his office will be attending the public hearing next week. Ms. Staneria also received a call this morning from a *Newland Times* reporter. The newspaper's chief editor, also a member of the NSFA, was contacted by Mr. Fin. The reporter requested information and will be attending the public hearing next week.

LIST OF ACRONYMS FOR CASE STUDY

AWQC - ambient water quality criterion

DFS - difestylonium

NAIF - Newlandia Arconalt Industry Federation

NEG - Newlandia Environmental Group

NPDES - National Pollutant Discharge Elimination System

NSFA - Newlandia Sport Fishermen's Association

NTA - Newlandia Tourism Association

ONRW - Outstanding National Resource Waters

WQS - water quality standards

INSTRUCTIONS FOR CASE STUDY EXERCISE

Working as a group representing the Newlandia water pollution control agency, design a preliminary risk communication strategy for handling this situation. Brainstorm ideas and answers to the following questions. Designate at least one person to record your answers and report your findings to all participants at the end of the exercise. You will have about 20 minutes to complete this exercise.

1. Audience. With what group or groups will you be communicating about risk and risk-related issues?

2. Audience Concerns/Questions. What types of questions are likely to be asked? What kinds of concerns are these groups likely to have?

3. Goals. Why are you communicating? What do you want to achieve through communication?

6. Communication Channels. In addition to the public hearing itself, what channels of communication might be appropriate to use in this situation? Why?

SOME RISK COMMUNICATION CHANNELS

Additional public meetings

Citizen's advisory group

Door-to-door visits

Information trailer

Social and community networks (e.g., voluntary, community-based, and professional organizations)

Public service announcements

Radio or TV advertisements

Interviews with press, radio, TV

Press releases

Press briefings

Speeches to local groups

Posted notices/posters

Fact sheets

Brochures, pamphlets

Hot line

Response to incoming calls (i.e., in the absence of a formal hotline number)

Libraries

Health professionals

Videotapes

7. Timing. When will you implement each of the various forms of communication you have decided on? (e.g., How soon will you hold a public meeting or distribute a flyer?)

8. Expertise. Who will be involved in each of the communication events? What kind of expertise would you like to have for each of these events? (e.g., What types of people should represent your team at a public meeting? Who should be involved in drafting and reviewing a fact sheet?)

VIDEO TRANSCRIPT

Antidegradation Policy: A Means to Maintain and Protect Existing Uses and Water Quality

13 minutes, 22 seconds

U.S. EPA
Office of Water
Office of Science and Technology
Standards and Applied Science Division

If you were to read that a public hearing took place, and that in the hearing someone objected to the proposed revisions to existing water quality standards because the revision violated the requirements of the State's antidegradation policy, would you understand just what was being said?

What is an antidegradation policy? From where did it come? What role does it play in protecting water quality? And How does it work?

In the next few minutes, we'll answer those questions, not in great detail, but in enough detail to provide you with the basic idea of what the antidegradation policy is all about.

In the late 1960s, when the first national effort to set water quality standards began, the quality of many of our rivers, lakes, streams, and harbors was poor. However, much of our water was of very high quality.

As the country began an extensive and expensive national cleanup of polluted waters, an interesting problem arose: How do we protect the waters that already had a quality that exceeded standards? To answer that question, it's important to recognize that water quality standards define the goals to be achieved in a waterbody—in terms of a use of the water—and in terms of the quality or criteria necessary to protect that use.

When you're dealing with water of poor quality, the solution is straightforward: you set the standards and clean up the water.

But, when the water is already better than the standard, is it possible to allow the water quality to be degraded down to the standard? Such a notion appeared to be illogical and contrary to the efforts going on to clean up the nation's water. Thus, the concept of antidegradation was born.

It was born in controversy and remains controversial, but its basic tenet of protecting existing use and water quality has remained unchanged through the years. The policy was not explicitly mentioned in the Clean Water Act until 1987, but the policy is rooted in the goal of the act to restore and maintain water quality. The antidegradation policy was established on February 9, 1968, by the Department of the Interior, the predecessor agency to EPA. Through the years, the policy has undergone modification, and the regulatory requirements for the policy are in the Water Quality Standards Regulation.

An antidegradation policy is one of the minimum elements required to be included in a State's water quality standards. One of the interesting things to remember about antidegradation is that it does not prohibit degradation of water quality, except in a very limited circumstance. Here's how it works: first of all, the antidegradation policy is not just one policy, but three separate policies rolled into one.

Part One of the policy says that any existing use, and the water quality necessary to protect that use, must be maintained and protected. You can call this the floor of water quality in the U.S. In simpler terms, it means that whatever the existing use of the waterbody is, you are not allowed to make it worse. If water quality needs to be improved to meet the standards, the control programs must be put in place to accomplish that. Consider that the concern of the policy is the uses of water, including swimming, boating, drinking, irrigation, various kinds of aquatic life uses, and many other uses. So, when a State sets a standard, it defines a use, and adopts water quality criteria to protect the use.

Within a range, different levels of water quality can protect a use. While in theory any improvement in water quality would improve a use, as a practical matter we cannot define uses that precisely, which is why the range is important. So, Part Two of antidegradation says that if water quality is better than needed to protect fishable/swimmable streams, the water quality can be allowed to deteriorate to the level that is required to maintain a fishable/swimmable use. This is what we call "Tier 2" of antidegradation, or high-quality water. For example: let's say a waterbody is classified by the State for fishable/swimmable purposes. The criterion set by the State happens to be 5.0 mg/L for dissolved oxygen. Someone goes out and monitors the actual water quality of the stream and finds out that the dissolved oxygen level is actually 6 mg/L. In terms of the policy that's clearly better, and certainly will foster the preservation and propagation of fish, shellfish, and wildlife, which is what "fishable" really means.

Of course, a State may allow the dissolved oxygen level of 6 to deteriorate to 5, which will meet the criterion and will still fully protect the existing use. However, the State cannot allow the dissolved oxygen level to go lower than 5 because the State has to protect the existing use, which is covered in Part One of the antidegradation policy.

It would not be unreasonable for people to say that it seems that we ought to keep the dissolved oxygen level at 6 because it represents better water quality. This brings us to the State's actual implementation of antidegradation, which requires the State to ask the public: Do we want to allow the water quality of this waterbody to degrade?

The State may make a decision to allow the degradation, or it may decide not to allow it. In all cases, the State is required to involve the public, and other Federal agencies, as necessary. The decision to allow deterioration in water quality is based on the finding that a lower water quality is necessary to support important economic and social development in the area in which the water is located.

Also, before water quality can be considered for possible degradation, the State municipalities and industrial dischargers must meet all the technologically based requirements of the act and must meet all cost-effective and reasonable best management practices for nonpoint source control. The point is that the antidegradation policy only required that the question about degradation be asked, and that a public decision be made based on data for the waterbody in question. The policy is neutral as to what the final decision should or should not be. Remember, the policy does not prohibit degradation except in one situation, and that situation is where the quality of water is exactly equal to that necessary to support the existing use.

A common question is: if a State implements antidegradation, is it a barrier against all economic development? The answer is no, because the public may decide that the economic development justifies the degradation. Of course, at other times the public decision will be that the economic development is not worth the environmental costs.

The Third Part of the antidegradation policy has to do with ONRW: Outstanding National Resource Water. This is a use classification created by EPA, which does not allow any degradation if the State classifies the waterbody as ONRW.

There are a couple key points to understand: First, there is no statutory or regulatory requirement that a State has to designate any waterbodies as ONRWs. And second, temporary water quality degradation is allowed if "temporary" is defined in terms of weeks and months, and not years. For example, if a sewer pipe ruptures, the water is likely to be fouled during the time it takes to make the repairs.

Now, let's look at what waters are supposed to be designated ONRWs. The name, Outstanding National Resource Water, implies something of pristine quality, and such waters certainly are candidates for the designation. However, any water of ecological significance can be a candidate. For example, a swamp might be considered to be very important ecologically, but the normal standards, use classifications, and water quality criteria don't apply particularly well. So, the State could designate the swamp as an ONRW and apply a special set of standards regarding it. And that's really the point: an ONRW should be applied to waters needing special protection, whether or not they actually have high-quality water.

Before discussing a couple of other points, let's summarize what we've covered so far: antidegradation began as a policy statement, not as a statutory requirement, but now it is contained in the Clean Water Act and in the Water Quality Standards Regulation.

The policy does not actually prohibit degradation except where the water quality actually matches what is needed to protect the use. In high-quality water, water quality can be degraded if a public decision is reached that determines that important economic and social development needs to be accommodated by lowering the water quality. And for special waters, called ONRWs, the policy in effect permits no water quality degradation at all.

Another important issue has to do with the relationship between EPA and the States. Simply put, EPA establishes the regulatory requirements to be met by the States. It is the State's policy that takes on the enforceable nature of a standard. At present, policies vary somewhat State by State, but EPA is working with the States to improve policy statements to bring them into direct compliance with EPA's regulations. So, the actual implementation of antidegradation is done by the States. It's the "how" aspect that is being brought into compliance. The States have been asked to develop an implementation method so that everyone knows how and when the policy will be applied and what decision-making criteria the State will use. This is where a lot of work remains to be done.

To help with this work, EPA provides, free of charge, the Water Quality Standards Handbook, which contains the guidance EPA has for the policy, and Questions and Answers on Antidegradation. These books and other information about the water quality standards program may be obtained from the U.S. Environmental Protection Agency, Office of Science and Technology, Standards and Applied Science Division, 401 M Street, SW (4305), Washington, DC 20460.

Information about the water quality standards program also may be obtained from EPA's Regional Offices at the addresses that follow. Contact the Water Quality Standards Coordinator at the appropriate Regional Office.

REGION 1

Environmental Protection Agency
John F. Kennedy Federal Building
Boston, MA 02203
(CONNECTICUT, MASSACHUSETTS, MAINE, NEW HAMPSHIRE, RHODE ISLAND, VERMONT)

REGION 2

Environmental Protection Agency
26 Federal Plaza
New York, NY 10278
(NEW JERSEY, NEW YORK, PUERTO RICO, VIRGIN ISLANDS)

REGION 3

Environmental Protection Agency
841 Chestnut Street
Philadelphia, PA 19107
(DELAWARE, MARYLAND, PENNSYLVANIA, VIRGINIA, WEST VIRGINIA, DISTRICT OF COLUMBIA)

REGION 4

Environmental Protection Agency
345 Courtland Street, NE
Atlanta, GA 30365
(ALABAMA, FLORIDA, GEORGIA, KENTUCKY, MISSISSIPPI, NORTH CAROLINA, SOUTH CAROLINA, TENNESSEE)

REGION 5

Environmental Protection Agency
230 South Dearborn Street
Chicago, IL 60604
(ILLINOIS, INDIANA, MICHIGAN, MINNESOTA, OHIO, WISCONSIN)

REGION 6

Environmental Protection Agency
1445 Ross Avenue
Dallas, TX 75202
(ARKANSAS, LOUISIANA, NEW MEXICO, OKLAHOMA, TEXAS)

REGION 7

Environmental Protection Agency
726 Minnesota Avenue
Kansas City, KS 66101
(IOWA, KANSAS, MISSOURI, NEBRASKA)

REGION 8

Environmental Protection Agency
999 18th Street
Suite 500
Denver, CO 80202-2405
(COLORADO, MONTANA, NORTH DAKOTA, SOUTH DAKOTA, UTAH, WYOMING)

REGION 9

Environmental Protection Agency
75 Hawthorne Street
San Francisco, CA 94105
(ARIZONA, CALIFORNIA, HAWAII, NEVADA, AMERICAN SAMOA, GUAM, TRUST TERRITORY OF THE PACIFIC ISLANDS, COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS)

REGION 10

Environmental Protection Agency
1200 Sixth Avenue
Seattle, WA 98101
(ALASKA, IDAHO, OREGON, WASHINGTON)

VIDEO TRANSCRIPT

Economic Considerations in Water Quality Standards

15 minutes, 47 seconds

This presentation will focus on the economic factors that are considered in the Water Quality Standards Process. We'll discuss WHY economics may be considered, describe WHERE, in the process, economics are considered, and we'll discuss HOW economic considerations are used in the water quality standards process. To appreciate WHY, WHERE, and HOW economic considerations might be involved in the water quality standards process, we first need to understand a few of the important aspects of water quality standards.

Under the Clean Water Act, States, Territories, and Indian Tribes — that qualify for treatment as States — are required to set water quality standards. The purpose of these standards is to protect public health, enhance the quality of the Nation's waters, maintain fish, shellfish, and wildlife resources, and preserve the public's recreational uses of the Nation's waters.

There are several major elements of the water quality standards process: States select waterbodies and designate the uses of the waterbodies — uses such as recreation and the protection of fish and wildlife. These uses may exist currently or they may be goals that could be attained in the future — with improved water quality.

Uses that are ultimately attainable are referred to as *designated uses*. States define their water quality standards in terms of these designated uses or goals, and in terms of scientifically determined criteria that limit pollutants to the level needed to protect the designated use.

A water quality standard, then, by definition requires a use and criteria to protect the use. Water quality standards also contain an antidegradation policy and a method of implementing it.

As part of the process, States develop water quality standards and hold public hearings to give the public an opportunity to review and comment on the proposed water quality standards. States hold public hearings at least once every three years to review existing water quality standards, to review proposed revisions to those standards, or to review new standards before they are adopted. After considering the information presented at the public hearings, States formally adopt water quality standards.

Then, the Environmental Protection Agency (EPA) reviews the standards to ensure they meet the requirements of the Clean Water Act. When standards meet these requirements, EPA approves them and States implement the standards.

To comply with water quality standards, anyone discharging wastewater into a waterbody may need to install treatment technologies, undertake pollution prevention techniques, or adopt best management practices.

There may be circumstances in which meeting water quality standards results in economic hardship to dischargers or to communities. In these situations, the Federal regulation governing water quality standards allows States to consider the costs and economic impacts of meeting the standards. The rest of this presentation provides an overview of how dischargers go about demonstrating economic hardship and of how EPA reviews State decisions regarding a determination of economic hardship.

Now let's discuss WHY economics can be considered. The Federal regulation governing water quality standards is not intended to be so stringent that it would have severe economic impacts on communities. Thus, there are several places in the water quality standards process WHERE economic considerations may be grounds for setting or changing the designated use of a waterbody.

In addition to economic considerations, there may be other reasons for changing standards, such as physical conditions that prevent the attainment of a use. The first place economic considerations are addressed occurs when a State designates uses of a waterbody. At this point in the process, a Use Attainability Analysis is performed. This analysis determines whether a designated use can realistically be achieved by studying the physical, chemical, biological, and economic factors associated with achieving a use.

To be more specific, a State may conduct a Use Attainability Analysis to remove a designated use — as long as it is not an existing use, and as long as it can be demonstrated that attaining the designated use is not feasible because the controls needed to meet the designated use will result in substantial and widespread economic and social impacts.

The second place where economics can be considered occurs if a State grants a variance to water quality standards. Variances are short-term exemptions from the standards that are used when the State is trying to determine whether the standard can be attained. The economic considerations for granting a variance are the same as those used when setting, modifying, or removing a designated uses — that is: the dischargers must demonstrate that substantial and widespread economic and social impacts would occur as a result of adopting the pollution reduction technologies or techniques necessary to meet water quality standards.

Federal regulation also allows economic impacts to be considered when States develop their antidegradation policy. In the case of the antidegradation policy, States may lower water quality only if the lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located.

So far, we've focused on the State's and the discharger's roles in the water quality standards process. The public also has a responsibility. You can attend public hearings when designated uses are being reviewed, when an application is being made for a variance, or when changes in a designated use are recommended. In addition, you have the right to submit comments on proposed changes to a designated use or on variances from water quality standards. Public involvement and participation are important aspects of the water quality standards process and are strongly encouraged by EPA.

Now, let's turn to HOW economic considerations are addressed. First, the State and the discharger must consider all the alternatives that would allow the discharger to meet water quality standards. These alternatives include pollution prevention, such as changing raw materials or substituting process chemicals; recycling and reuse; as well as end-of-pipe treatment. These alternatives are often associated with increased costs.

When we think HOW economic considerations fit into the water quality standards process, a chief concern is WHO will bear the costs of complying with water quality standards.

Although States are responsible for setting water quality standards, individual wastewater dischargers may seek relief from these standards because of their costs of compliance. Dischargers may be either private entities or public entities. By private entities, we mean operations like industrial facilities, recreational developments, and shopping centers.

When we speak of public entities, the most common example is a sewage treatment plant.

There are also situations in which private entities (such as industrial facilities) discharge their waste to public sewage treatment plants. In such cases, both the private and public entities can suffer — and claim — economic hardship. In addition, adverse economic impacts from compliance costs can affect both point and nonpoint sources of pollution.

Point sources include discharges from a single point of origin. Nonpoint sources are those that do not have a single point of origin, such as runoff from road construction or from a farm.

As I mentioned, to change water quality standards for economic reasons, the discharger must demonstrate that the economic impact of complying with water quality standards will be "substantial" and "widespread." The substantial part of "substantial and widespread" focuses on the cost of pollution reduction and on the discharger's ability to pay for necessary pollution reductions.

In considering the ability to pay, various aspects of the discharger's financial health should be reviewed. Does the discharger have ample financial resources? Would the discharger have difficulty raising the money to make the capital investment in pollution reductions? And, how would the discharger's profitability be affected?

For a private entity, like a manufacturer, raising the money might require a loan from a bank. For a public entity, like a municipality, raising the money might require an increase in sewer system user fees or in local taxes.

To demonstrate that economic impacts will also be "widespread," the discharger must show that complying with the water quality standards will result in significant adverse impacts to the community — not just to the discharger.

To do this, the discharger must define what the affected community would be — by identifying who will bear the adverse impacts. The discharger must also evaluate the current characteristics of the community.

Some examples of important characteristics to consider include household income, unemployment, expenditures on social services, and the amount of tax revenues currently paid to the community by the discharger. Next, the discharger needs to demonstrate what the impacts would be if the discharger were forced to meet water quality standards. Would people lose their jobs? Would other economic activities be affected? Will the community lose out on development opportunities? Because these impacts are site-specific, the decision as to whether the impacts are "widespread" must be based on local conditions.

The EPA can provide you with information on the data and financial indicators that dischargers should use to demonstrate economic hardship and that the States and EPA use to evaluate the economic impact to the discharger.

These financial indicators are standard analytic tools used by businesses and governments to make decisions about their operations — such as when they evaluate potential investments or expansions.

Measures of the impacts on the discharger and on the community help the States and EPA understand the complexity and specifics of each situation. With information about the financial and social costs, the States and EPA are better able to balance the need for pollution reductions with the other needs of the community.

In summary, it's important to remember that Water Quality Standards are designed to protect public health, enhance the quality of the Nation's waters, maintain natural resources, and preserve the public's recreational uses.

In addition, the important task of protecting water quality can include economic considerations, because Federal regulations require that costs and impacts at specific sites be a factor in developing water quality standards.

For additional information and to learn more about the water quality standards program and about the role economic considerations play in water quality standards, contact EPA or your State water pollution control agency — or its equivalent. Educational materials and information can be obtained from the following addresses:

MESA CITY, NEWLANDIA, CASE STUDY

SCENARIO

This case study is based on a variance request by Mesa City, Newlandia, which is located on the Winding River.

The city council for Mesa City objects to the Winding River Use Attainability Analysis completed by the state, claiming that the water quality standards were overprotective. City lawyers argue that the effluent limitations needed to meet the water quality standards would be burdensome to the city. To meet the water quality standards, Mesa City would have to upgrade its existing secondary treatment plant.

Mesa City is now applying for a variance from effluent limitations required to meet the Class 1 aquatic life classification for the Winding River. The applicant is Mesa City, which operates the Winding River Treatment Plant. The treatment plant is in violation of the standards based on the concentration of ammonia present in its wastewater. The variance requested is a reduction in the stringency of the ammonia standards the treatment plant must meet.

MESA CITY, NEWLANDIA, SUMMARY

Mesa City's Demographics

Population (1990)	38,000
Current Population (1996)	34,200 (decrease of 10% since 1989)
Type of household moving away from Mesa City	Single-person households and smaller two-income families
Number of households	12,100
Median Household Income (U.S. Census, Census Designated Place)	$15,000
Median Household Income (Local Planning Board Estimates, City)	$17,500
Median Household Income (U.S. Census, State)	$17,400
Median Household Income (U.S. Census, County)	$16,300
Major Type of Employment	Oil industry, Service sector
Regional Economic Conditions	Decline of oil industry
Percentage of Total Wastewater Flow Attributable to Residential and Municipal Wastewater Flows	85%
Unemployment Rate (City)	6.1%
Unemployment Rate (County)	5.9%
Unemployment Rate (State)	5.6%

Mesa City's Financial History

Property Tax Revenues (1990)	$13,042,000
Sales Tax and Miscellaneous Revenues (1990)	$8,301,000
Total Government Revenues (1990)	$21,343,000
Property Tax Revenues (FY 1995)	$10,725,000
Sales Tax and Miscellaneous Revenues (FY 1995)	$5,775,000
Total Government Revenues (FY 1995)	$16,500,000

Current Market Value of Taxable Property (FY 1994)	$753,382,000
Property Tax Delinquency Rate	5.5% (up from 1% prior to 1988)
Bond Rating — insured sewer	S&P rating of AAA
Bond Rating — non insured sewer	S&P rating of BBB
Overall Net Debt (FY 1995)	$31,335,000
<u>Cost of Wastewater Treatment Upgrade</u>	
Capital Improvements	
1990 dollars	$2,500,000
1994 dollars	$3,300,000 (using ENR capital cost index of 1.32)
Annual Operating Costs	
1990 dollars	$750,000
1994 dollars	$802,500 (using ENR operating cost index of 1.07)
<u>Financing for Wastewater Treatment Upgrade</u>	
Source of Financing	General obligation bond
Repayment Term, Vehicle	20 years, property and sales tax revenues
Bond Rate	8.45% (optimistic), 11% (realistic)
Total Annual Cost of Existing Plant	$2,950,500

WORK SHEET FOR THE MESA CITY, NEWLANDIA CASE STUDY

I. Calculating the Municipal Affordability Screener

A. Calculate Average Annualized Cost Per Household

1. Calculate the Total Annual Cost of the Project

Interest Rate for Financing (i) = __________ (expressed as a fraction)

Time Period for Financing (n) = __________ years

Annualization Factor $\left(\frac{i}{(i+1)^n + 1} + i\right)$ = **0.1052865** (1)

Total Capital Cost of Project to be Financed = **$ 3,300,000** (2)

Annual Operating Costs of Project = **$ 802,500** (3)

Annualized Capital Cost [(1) *x* (2)] = __________ (4)

Total Annual Cost of Project [(3) + (4)] = __________ (5)

2. Calculate the Total Annual Cost to Households

Total Annual Cost of Project (5) x Percentage of Total Wastewater Flow Attributable to Residential and Municipal Wastewater Flows = **$ 977,453** (6)

Total Annual Cost of Existing Plant ($2,950,500) x Percentage of Total Wastewater Flow Attributable to Residential and Municipal Wastewater Flows = __________ (7)

Total Annual Cost to Households [(6) + (7)] = **$ 3,485,378** (8)

3. Calculate the Average Annualized Cost Per Household

$$\frac{\textit{Total Annual Cost to Households (8)}}{\textit{Number of Households}} =$$ __________ (9)

B. Calculate Screener Value:

$$\frac{\textit{Average Annualized Cost Per Household (9)}}{\textit{Median Household Income}} \times 100 = \qquad \% \ (10)$$

What type of impact does the Municipal Affordability Screener Indicate? impact

Is there a need to proceed to the Secondary Affordability Test? ______

II. Applying the Secondary Affordability Test

A. Evaluating the **Debt Indicators:**

Bond Rating:

What is Mesa City's Bond Rating? ______________

What is the resulting score? (Slide 15) ______________ points (11)

Overall Net Debt to Market Value of Taxable Property:

Mesa City's Overall Net Debt = **$ 31,355,000** (12)

Mesa City's Market Value of Taxable Property = **$ 753,382,000** (13)

$$\frac{\textit{Overall Net Debt (12)}}{\textit{Market Value of Taxable Property (13)}} \times 100 = \qquad \%$$

What is the resulting score? (Slide 16) ______________ points (14)

B. Evaluating the **Socioeconomic Indicators:**

Unemployment Rate:

What is Mesa City's Unemployment Rate? ______________

Is this above or below the State's rate? ______________

What is the resulting score? (Slide 17) ______________ points (15)

Median Household Income:

What is Mesa City's Median Household Income? ____________________

Is this above or below the State's rate? ____________________

What is the resulting score? (Slide 18) ____________________ points (16)

C. Evaluating the **Financial Management Indicators:**

Property Tax Revenue to Full Market Value of Taxable Property:

What is Mesa City's Property Tax Revenue? **$ 10,725,000** (17)

What is the Full Market Value of Taxable Property? **$ 753,382,000** (18)

$$\frac{\textit{Property Tax Revenue (17)}}{\textit{Full Market Value of Taxable Property (18)}} \times 100 = \underline{\qquad\qquad} \%$$

What is the resulting score? (Slide 19) ____________________ points (19)

Property Tax Collection Rate:

What is the Property Tax Collection Rate of Mesa City? ____________________

What is the resulting score? (Slide 20) ____________________ points (20)

D. Calculate the Cumulative Secondary Affordability Test Score:

$$\frac{(11) + (14) + (15) + (16) + (19) + (20)}{6} = \qquad \text{points (21)}$$

III. Assessment of Substantial Impacts Matrix

The Municipal Affordability Screener (10) = ________________ %

The Cumulative Secondary Affordability Test Score (21) = _ points

Where does Mesa City appear in the Substantial Impacts Matrix below?

Secondary Assessment Score (Cumulative Secondary Affordability Score)	**Municipal Affordability Screener** (Average Annualized Pollution Control Cost as a Percentage of Median Household Income)		
	<0.8%	0.8% - 1.5%	>1.5%
< 1.5	?	X	X
1.5 — 2.5	✓	?	X
> 2.5	✓	✓	?

? Questionable affordability
✓ Community can afford the pollution control
X Community cannot afford the pollution control

Can Mesa City afford the upgrade to their facility? ________________

MUNICIPAL AFFORDABILITY SCREENER FOR MESA CITY

$$= \frac{\text{Average Annualized Cost per Household}}{\text{Median Household Income}}$$

$$= \frac{\$288.05}{\$15{,}000.00} \times 100$$

$$= 1.92\ \%$$

EPA

SECONDARY AFFORDABILITY TEST FINANCIAL MANAGEMENT INDICATORS FOR MESA CITY

Measure 1

$$= \frac{\text{Property Tax Revenue}}{\text{Full Market Value of Taxable Property}}$$

$$= \frac{\$10{,}725{,}000}{\$753{,}382{,}000} \times 100$$

$$= 1.42\ \%$$

EPA

SOURCES OF SOCIOECONOMIC INFORMATION FOR WATER QUALITY STANDARDS

Public Entity

For public entities, it is necessary to determine whether or not a community can afford a project. To obtain information on the social and economic strength of the community, consider the following options.

For information on bond ratings, contact:

Standard & Poor's (S&P) Ratings Service Home Page
S&P Service is the largest global bond rating agency. S&P via Internet: *http://www.mcgraw-hill.com/financial-markets/ratings/ratings/htm*

For information on debt/market value, contact:

County Board of Taxation

For information on unemployment and household income, contact:

U.S. Bureau of the Census, Public Information Office, Room 2705, Building 3, Washington, DC 20133; phone (301)763-4040. U.S. Census Gopher Server via Internet: *http://www.census.gov*

Bureau of Economic Analyses (BEA). BEA measures and analyzes U.S. economic activity. BEA via Internet: *http://www.doc.gov/resources/csd/csbea.html*

County or State Chamber of Commerce (request a relocation package or socioeconomics fact sheet)

Local planning office or economic development office

State Department of Labor

For information on taxes, property values, and collection rates, contact:

County Board of Taxation

County or State Chamber of Commerce (request a relocation package or socioeconomics fact sheet)

Local planning office or economic development office
State Department of Labor

Private Entity

For private entities, it is necessary to assess the entity's ability to pay for water pollution controls along with its financial health. To obtain information on the financial strength of the entity, ask for such items as cash, inventories, accounts receivable, accounts payable, accrued expenses, taxes, and the current portion of any long-term debts.

For information to help perform the Liquidity Test (current assets divided by current liabilities); Solvency Test (cash flow per given year divided by total debt of the entity); Leverage Test (amount firm has borrowed divided by amount of stockholders' capital); or Earnings Test (annualized pollution control cost subtracted from pretax earnings), consider the following options:

Obtain a copy of the entity's balance sheet.

Obtain a copy of the annual report.

With permission, call the entity's bank to request line of credit information.

Commission a credit bureau to run a credit analysis.

Refer to Robert Morris Associates' *Annual Statement Studies* or Moody's *Industrial Manual.*

Community

To demonstrate that economic impacts will be widespread, one must show that the surrounding community will incur an adverse impact. To obtain information on the demographics and financial status of the community, consider the following options.

For information on the geographic area of the affected community, purchase a map of the area from the U.S. Geological Survey, Rand-McNally, etc., or contact:

U.S. Census Gopher Server Map Locator via Internet: *http://www.census.gov*

County or State Chamber of Commerce

For information on population, contact:

U.S. Bureau of the Census, Public Information Office, Room 2705, Building 3, Washington, DC 20133; phone (301)763-4040. U.S. Census Gopher Server via Internet: *http://www.census.gov*

County or State Chamber of Commerce (request a relocation package or socioeconomics fact sheet)

For information on financial surplus as a percentage of total expenditures, contact:

Local planning office or economic development office

For information on tax revenues and property values, contact:

County or State Chamber of Commerce (request a relocation package or socioeconomics fact sheet)

Local Planning Office or Economic Development Office

The State's Department of Labor

For information on overall debt outstanding, contact:

Local planning office or economic development office

For information on employment/unemployment rates, contact:

U.S. Bureau of the Census, Public Information Office, Room 2705, Building 3, Washington, DC 20133; phone (301)763-4040. U.S. Census Gopher Server via Internet: *http://www.census.gov*

Bureau of Economic Analyses (BEA). BEA measures and analyzes U.S. economic activity. BEA via Internet: *http://www.doc.gov/resources/csd/csbea.html*

County or State Chamber of Commerce (request a relocation package or socioeconomics fact sheet)

Local planning office or economic development office

State Department of Labor

For additional assistance on any of the subjects above, you can call EPA, Office of Water, Office of Science and Technology, Engineering and Analysis Division, Economic and Statistical Analysis Branch, in Washington, DC; phone (202)260-5397.

ATTORNEY GENERAL'S CERTIFICATION

Governor __(Name)__
__(City)__, __(State)__

Dear Governor _____:

I have reviewed the proposed Amendments to the Rules and Regulations Establishing Surface Water Criteria for the State of ______, as adopted by the (State Agency) on (date), following a public hearing held by the Department on (date). The amended rules and regulations were duly adopted pursuant to the authority contained in the (State Act citation). The hearing was held in accordance with the provisions of the (State Act citation).

The proposed regulations amend the use classifications and certain criteria assigned to protect those classifications previously approved by the Environmental Protection Agency on (date). These proposed regulations apply to all navigable waters in (State).

On the basis of the above, I have concluded that the Rules and Regulations Establishing Surface Water Criteria for the State of _______ have been promulgated in accordance with State law and that they will be legally enforceable in the State.

Signature

(Attorney General's name)

(STATEMENT MAY BE ADDRESSED TO
DEPARTMENT HEAD, GOVERNOR, OR
EPA REGIONAL ADMINISTRATOR)

SUMMARY OF FEDERAL WATER QUALITY STANDARDS RULEMAKINGS

(January 31, 1996)

STATE	DATE	ACTION	REFERENCE	DESCRIPTION
1. Kentucky	12/2/74	Final Rule	39 FR 41709	Established statement in WQS giving EPA Administrator authority to grant a temporary exception to stream classification and/or criteria after case-by-case studies. Also, established statement that streams not listed in the WQS are understood to be classified as Aquatic Life and criteria for this use to be met.
	12/9/80	Withdrawal	45 FR 81042	Withdrew the Federal promulgation action of 12/2/74 after adoption of appropriate water quality standards by the State.
2. Arizona*	6/22/76	Final Rule	41 FR 25000 (40 CFR 131.31)	Established nutrient standards for 11 streams.
3. Nebraska	6/6/78	Final Rule	43 FR 24529	Redesignated eight stream segments for full body contact recreation and three for partial body contact recreation and the protection of fish and wildlife.
	7/26/82	Withdrawal	47 FR 32128	Withdrew Federal promulgation action of 6/6/78 after adoption of appropriate water quality standards by the State.
4. Mississippi	4/30/79	Final Rule	44 FR 25223	Established dissolved oxygen criterion for all water uses recognized by the State. Established criterion for a daily average of not less than 5.0 mg/l with a daily instantaneous minimum of not less than 4.0 mg/l.
	4/4/86	Withdrawal	51 FR 11581	Withdrew the Federal promulgation of 4/30/79 following State adoption of requirements consistent with the Federally promulgated standard.

STATE	DATE	ACTION	REFERENCE	DESCRIPTION
5. Alabama	11/26/79	Proposed Rule	44 FR 67442	Proposal to reestablish rule previously approved use classifications for segments of four navigable waterways, Five Mile Creek, Opossum Creek, Valley Creek, Village Creek, and upgrade the use designation of a segment of Village Creek from river mile 30 to its source. [This proposal was never finalized or removed.]
6. Alabama	2/14/80	Final Rule	45 FR 9910	Established beneficial stream use classification for 16 streams: 8 were designated for fish and wildlife, 7 were upgraded to a fish and wildlife classification, 1 was designated as agricultural and industrial water supply. Proposed streams classification rulemaking for 7 streams withdrawn.
	11/26/82	Withdrawal	47 FR 53372	Withdrew the Federal promulgation action of 2/14/80 following State adoption of requirements consistent with the Federally promulgated standard.
7. North Carolina	4/1/80	Final Rule	45 FR 21246	Nullified a zero Carolina dissolved oxygen standard variance in a segment of Welch Creek and reestablished the State's previous standard of 5 mg/l average, 4 mg/l minimum, except for lower concentrations caused by natural swamp conditions.
	11/10/81	Withdrawal	46 FR 55520	Withdrew the Federal promulgation action of 4/1/80 following State adoption of a dissolved oxygen criterion consistent with the Federally promulgated standard.

STATE	DATE	ACTION	REFERENCE	DESCRIPTION
8. Ohio	11/28/80	Final Rule	45 FR 79053	(1) Established water use designation, (2) established a DO criterion of 5 mg/l for warmwater use, (3) designated 17 streams as warmwater habitat, (4) placed 111 streams downgraded by Ohio into modified warmwater habitat, (5) revised certain provisions relating to mixing zones (principally on Lake Erie), (6) revised low flow and other exemptions to standards, (7) amended sampling and analytical protocols, and (8) withdrew EPA proposal to establish a new cyanide criterion.
	2/16/82	Withdrawal	47 FR 29541	Withdrew Federal promulgation of 11/28/80 because it was based on a portion of the water quality standards regulation that has been determined to be invalid.
9. Idaho	8/20/85	Proposed Rule	50 FR 33672	Proposal to replace DO rule criterion downstream from dams, partially replace Statewide ammonia criterion, replace ammonia criterion for Indian Creek, and delete categorical exemption of dams from Anti-degradation Policy.
	7/14/86	Partial Withdrawal of Proposal	51 FR 25372	Withdrew portions of withdrawal proposed rule to of replace DO criterion proposal downstream from dams and delete categorical exemptions of dams from antidegradation rule since State adopted acceptable standards in both instances.
	7/25/88	Completed Withdrawal of Proposal	53 FR 27882	Withdrew portion of withdrawal proposed rule which of would have established proposal a Statewide ammonia criterion and a site-specific ammonia criterion applicable to lower Indian Creek since State adopted acceptable standards.

STATE	DATE	ACTION	REFERENCE	DESCRIPTION
10. Kentucky	3/20/87	Final Rule	52 FR 9102	Established a chloride criterion of 600 mg/l as a 30-day average, not to exceed a maximum of 1,200 mg/l at any time.
	4/3/91	Withdrawal	56 FR 13592	Withdrew the Federal promulgation of 3/20/87 after adoption of appropriate chloride criterion by the State.
11. Colville Confederated Tribes Reservation*	7/6/89	Final Rule	54 FR 28622 (40 CFR 131.35)	Established designated Confederated (40 CFR 131.35) uses and criteria for Tribes all surface waters on Reservation the Reservation at the Tribes' request.
12. 12 States 1 Territory District of Columbia	12/22/92	Final Rule	57 FR 60848 (40 CFR 131.36)	Established numeric water quality criteria for toxic pollutants (aquatic life and human health) and certain minimum implementing requirements. Generally called "National Toxics Rule."
Washington	7/6/93	Partial Withdrawal	58 FR 36141	Withdrew, in part, the withdrawal applicability to the State of the National Toxics Rule of 12/22/92 after adoption of some appropriate criteria by the State.
	5/4/95	Interim Final Rule	60 FR 2228	Converted metals criteria in National Toxics Rule based on the total recoverable form to criteria based on dissolved form by the use of laboratory-derived conversion factors. This action was agreed to pursuant to a partial settlement of litigation.
13. New Mexico	10/18/94	Proposed Rule	59 FR 52496	Proposed to supersede a State mixing zone provision that would allow acute numeric criteria to be superseded by biomonitoring. (This Proposal is inactive as the State has taken corrective action. See EPA's Reg. Agenda at 60 FR 23969.)

STATE	DATE	ACTION	REFERENCE	DESCRIPTION
14. California*	1/24/95	Final Rule	60 FR 4664 (40 CFR 131.37)	Established four sets of Federal criteria to protect the habitat conditions of the San Francisco Bay - Sacramento and San Joaquin Rivers Delta Estuary to protect endangered species and other aquatic life.
	12/20/95	Proposed Rule	60 FR 2766	EPA has proposed to withdraw the Bay/Delta rule because the State has adopted requirements which are judged to be equivalent to EPA's rule.
15. Arizona	1/29/96	Proposed Rule	61 FR 2766	EPA proposed, pursuant rule to a U.S. District Court order, to remove a mining exemption from the definition of navigable waters, add fish consumption to AZ's fishable uses, nullify setting WQS on analytical "practical quantitation limits", and certain implementation policies.

Note: Asterisk (*) indicates that the rule is still in effect and can be found at the citation provided in the Code of Federal Regulations.