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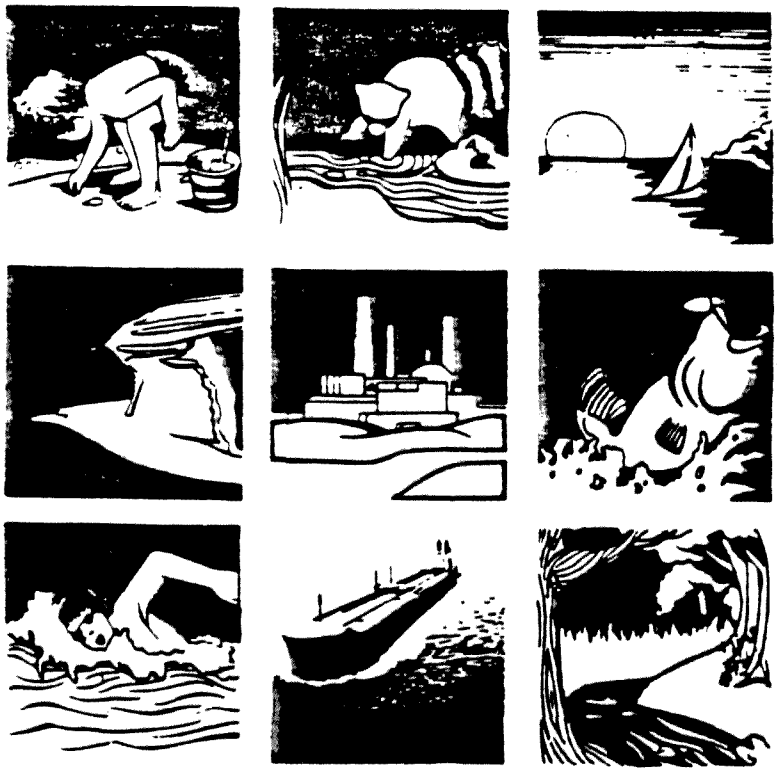
REGULATORY APPLICATIONS OF SEDIMENT CRITERIA



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FINAL REPORT

on

REGULATORY APPLICATIONS OF SEDIMENT QUALITY CRITERIA

to:

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ABSTRACT

This report briefly describes the approach being used to develop sediment quality criteria, discusses their utility and appropriate regulatory applications, and recommends steps to enhance the acceptance of sediment criteria by the regulatory and regulated communities. The report is based on the collective input from chemists, biologists, and aquatic toxicologists working on sediment criteria development for EPA, and the results of a survey of individuals in the regulatory and regulated communities who are interested in and could potentially use sediment criteria.

The first criteria values developed will be useful in identifying potential problem areas and, in some cases, in identifying areas where additional studies are needed to determine the likelihood of adverse impacts. Sediment criteria will be useful in implementing a number of laws, primarily those involving siting, permitting, or monitoring of waste disposal; identifying or cleaning up contaminated areas; and preparing environmental impact statements. The development of sediment criteria is a new effort and the exact role of these criteria in environmental protection is in the earliest stages of formulation. As our understanding of the impacts of contaminated sediments improves and the role of sediment criteria in regulatory applications becomes better defined, it is important that this progress be communicated to all individuals and organizations who are interested in and/or may be affected by sediment criteria. Continuing scientific review of the criteria development effort is essential.

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1.0 INTRODUCTION

Sediment quality has been of interest to scientists for years because many contaminants in the aquatic environment accumulate to higher concentrations in sediments than in the overlying water. Contaminated sediments may, in turn, act as a source from which these contaminants can be released into the overlying waters. To better accomplish their environmental protection missions, regulatory agencies have continually sought a scientific basis for regulating contaminants in sediments. Because sediments play a key role in contaminant interactions with the aquatic environment, they are of great interest in a large and growing number of regulatory programs. The differing objectives and priorities of these programs result in a variety of potential applications for sediment criteria. This report summarizes these potential applications, recommends uses for sediment criteria, and discusses limitations of sediment criteria. In this document the term "sediment quality criteria" is used in a general sense to refer to numerical values, however they are derived, indicating environmental effects of contaminants associated with sediments.

2.0 BACKGROUND

The development of water quality criteria (EPA, 1980) has been one of the major continuing efforts in protection of the aquatic environment. These criteria address the potential impacts of dissolved contaminants in the water column. It has long been recognized that dissolved chemicals become associated with, and accumulate in, sediments. Although this accumulation has resulted in significant environmental effects, techniques were not available for developing sediment criteria applicable on a national level to sediments covering a wide range of

characteristics. Impact assessment guidance based on the presence of elevated concentrations of chemicals in the sediment was developed in some areas (Engler, 1980). However, sediment criteria based on a relationship between contaminant concentrations on the sediments and biological effects were not developed. This was a result of inadequate scientific understanding of the complex ways that mineral and organic constituents in sediments interact to influence the biogeochemical behavior, and thus the biological effects, of contaminants.

In the absence of biological effects-based sediment criteria, a variety of approaches emphasizing the presence of contaminants in sediments have been used to evaluate potential environmental effects of contaminated sediments. Examples of such approaches (reviewed by Engler, 1980) include physical characterizations, sanitary engineering measurements (e.g., biological oxygen demand), and bulk or total sediment chemistry. A more effects-oriented approach compared the concentration in sediment elutriates to effects-based water quality criteria (EPA, 1975). Only recently have bioassays and bioaccumulation tests been widely used to directly evaluate the potential environmental effects of contaminated sediments (EPA/CE, 1977).

All the approaches mentioned above, as well as many variations on these approaches, had specific characteristics that made them more suitable for some applications than for others, and almost as many sediment evaluation techniques were developed as there were programs dealing with sediment contamination problems. These approaches were of little use on a national basis because the results from one sediment could not be extrapolated to other sediments. Thus, the evaluation had to be repeated for every site or sediment of concern. Over the past dozen years, scientific advances in a number of fields have combined to

improve our understanding of the environmental behavior of several classes of contaminants in sediments enough to allow development of effects-based sediment criteria that are applicable to a range of sediments.

3.0 OBJECTIVES AND APPROACH

The objectives of this report are to

- Identify the regulatory programs of EPA in which sediment criteria could be most useful,
- Recommend current and potential uses of sediment criteria by EPA,
- Evaluate the utility, including both appropriate applications and limitations, of sediment criteria to major regulatory programs.

This report is based on the contributions of persons with knowledge of the biological, chemical, and legislative issues relevant to sediment contamination and sediment criteria development. In addition, a survey of the regulating and regulated communities was conducted to verify the needs and potential uses of sediment criteria in specific environmental programs. Based on their involvement with sediment-related environmental regulations, a total of 29 individuals were selected to participate in the survey. The survey used a questionnaire designed to direct the respondents through a discussion of three major topics (1) the need for sediment criteria, (2) the characteristics that would make the criteria suitable for their applications (including legislative applicability), and (3) the specific chemicals for which sediment

criteria are needed. Detailed questions on each topic encouraged each respondent to consider each subject in depth. Interviews were conducted with individuals from eight EPA Regional Offices, three EPA Environmental Research Laboratories, five EPA Headquarters Offices, two offices of the National Oceanic and Atmospheric Administration (NOAA), five offices of the Army Corps of Engineers, three state regulatory offices, two academic institutions, and one public utility environmental affairs office. A complete description of the survey and a discussion of the results are presented in Appendix A.

4.0 OVERVIEW OF DEVELOPMENT OF SEDIMENT QUALITY CRITERIA

In November 1984 and February 1985, workshops of experts in environmental chemistry, environmental toxicology and related areas were held to review available data and recommend an approach for estimating sediment criteria for contaminants. These workshops (Neff, 1985) agreed that the equilibrium partitioning approach was a useful basis for developing numerical, chemical-specific sediment criteria for non-polar organic contaminants and metals. The approach for developing sediment criteria is consistent with EPA's general approach of developing numerical criteria for individual chemicals. Since May 1985, EPA has been involved in verification of the approach and in development of the necessary database for estimating sediment criteria. Because polar organic contaminants were found to be only a very small percentage of contaminants of concern in sediments and a method for modifying the equilibrium partitioning approach for polar contaminants was not evident from the available data, no effort was initiated for that class of contaminants.

The equilibrium partitioning approach relates the biological effects of contaminants on sediments to the partitioning of the contaminant to the interstitial water. This approach has two basic assumptions. First, the interstitial water concentration of the contaminant can be calculated from the concentration of the sorbent phases on the sediment, the partition coefficients, and the concentration of the contaminant on the sediment. Second, the toxicity of the contaminant to benthic organisms can

be related to the concentration of the contaminant in the interstitial water. Thus, toxicity data for a contaminant in water exposure can be used to calculate the concentration of contaminant on the sediment that will result in a certain toxicity.

Current research at Battelle, EPA laboratories, and several universities is generating data that support the key assumptions of the equilibrium partitioning approach. Within the next few years, these development efforts will provide sediment quality criteria for non-polar organic contaminants. These criteria will be based on chronic water quality criteria or on appropriate water quality advisories. The water quality criteria and advisories will be used to establish "no-effect" or "specific-effect" concentrations in the interstitial water. The concentrations of contaminants on the sediment that at equilibrium will result in these interstitial water concentrations will be calculated based on partitioning coefficients. In the absence of chronic water quality criteria or appropriate advisories, other toxicological points (e.g., lowest observed effects levels) might be used to calculate the sediment values, if appropriate, for specific regulatory applications. There will, of course, be less confidence in the protection afforded by these sediment values than for sediment values based on chronic criteria and advisories. The

desirability of using lowest observable effects level or other bases for estimating sediment quality values will need to be carefully evaluated in the context of the specific application.

Because the partitioning coefficients for many of the non-polar organic contaminants are known only within some confidence interval, a statistical uncertainty analysis was performed to provide confidence limits for the sediment criteria values (Pavlou et al., 1987). These confidence intervals could be appropriate for determining the relative probability that a particular sediment concentration exceeds or meets the sediment criteria. This "grey area" of sediment quality is referred to in the application sections of this document. Specific interpretation of the relative quality of a sediment based on this "grey area" will need to be determined by each regulatory program in light of the program's mandate.

Just as procedures for development of water quality criteria are constantly being reviewed and improved, methods used in the development of sediment criteria can be expected to undergo similar review and improvement. These efforts will result in a progressively broader range of applications and greater confidence in the criteria values.

5.0 SUMMARY OF THE MAJOR REGULATORY PROGRAMS WITH SEDIMENT QUALITY CRITERIA COULD BE APPLIED

The Clean Water Acts of 1977 and 1987 give the U.S. Environmental Protection Agency (EPA) regulatory authority to develop sediment criteria, as does other legislation (Table 1). Under the Clean Water Act, EPA has the responsibility for protecting the chemical, physical, and biological integrity of the Nation's waters. Section 104 of the 1977 Act for example, authorizes EPA

TABLE 1. SOME OF THE MAJOR LAWS AND THE SECTIONS WITHIN THESE LAWS TO WHICH SEDIMENT CRITERIA MAY BE RELEVANT.

LAW	PURPOSE
Clean Water Act of 1977	Establishes authority to restore and maintain the chemical, physical, and biological integrity of the Nation's waters.
Section 115	Provides authority to identify the location of in-place pollutants with emphasis on toxic pollutants in harbors and navigable waterways.
Section 301	Establishes effluent limitations.
301(b)	Provides for effluent limitations for priority pollutants from point sources, other than publicly owned treatment works.
301(h)	Modifies discharge permits for discharge from publicly owned treatment works.
Section 402	Authorizes the National Pollution Discharge Elimination System (NPDES) for regulating the discharge of pollutants from point sources.
Section 404	Establishes permits for discharge of dredged or fill material into navigable waters of the U.S.
Clean Water Act of 1987	Establishes authority to protect the chemical, physical, and biological integrity of the Nation's waters.
Section 104	Establishes national programs for the prevention, reduction, and elimination of pollution through research, experiments, and demonstrations.
Section 118	Requires annual reports on the status of pollutants in sediments of the Great Lakes, and removal of sediments with toxic pollutants.

TABLE 1. (Continued)

LAW	PURPOSE
Section 304(a)	Authorizes development and publication of criteria reflecting the scientific knowledge on the environmental effects of pollutants.
Marine Protection, Research, and Sanctuaries Act of 1972	Provides authority to regulate the transportation for dumping and the dumping of material into ocean waters.
Section 102	Authorizes dumping permits for sewage sludge and industrial wastes.
Section 103	Authorizes permits for transportation of dredged material for the purpose of dumping into ocean waters.
Resource Conservation and Recovery Act of 1976	Authorizes efforts to promote the protection of health and environment and to conserve valuable material and energy resources by regulating the treatment, storage, and transportation of hazardous wastes that have adverse effects on health and the environment.
Section 301	Establishes criteria for identification and listing of hazardous waste.
Toxic Substances Control Act	Authorizes regulation of chemical substances and mixtures that present an unreasonable risk of injury to health or the environment.
Section 4(a)	Authorizes development of testing methods including toxicity testing.

TABLE 1. (Continued)

LAW	PURPOSE
Section 4(e)	Authorizes development of priority list for promulgation of procedures under Section 4(a).
The Federal Insecticide, Fungicide, and Rodenticide Act	Gives authority to protect health and environment against unreasonable adverse effects from application of insecticides, fungicides, and rodenticides.
National Ocean Program Act	Confers authority to coordinate pollution programs amongst the federal agencies involved in marine research, monitoring, and regulations.

to establish national programs for prevention, reduction, and elimination of pollution through research, experiments, and demonstrations. Section 304(a)(1) directs EPA to develop and publish criteria for water quality that reflect the latest scientific knowledge on the environmental effects of pollutants, including factors affecting organic and inorganic sedimentation, in various types of receiving waters. Section 404 authorizes the development from approaches to prevent unacceptable adverse impacts from discharges of dredged or fill material into waters of the United States. Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (MPRSA or Ocean Dumping Act) also provides for the development of approaches to evaluate and regulate the environmental effects of discharges, including dredged material, into the ocean. Table 1 summarizes the major legislation that provides explicit or implicit authority for EPA to develop and implement sediment criteria.

Seventy-six percent of those interviewed in our survey cited the Ocean Dumping Act and the Clean Water Act as mandates for regulating contaminated sediments. Other respondents cited mandates under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Toxic Substances Control Act (TSCA), which establish regulations for chemicals being registered or re-registered. Also cited were Superfund, Great Lakes Sediment Quality Guidelines, and the NPDES Program. In addition, other Federal agencies will probably use EPA's sediment criteria in their own environmental regulations. States are also likely to use any sediment criteria developed by EPA as a basis for State standards. The potential impact of sediment criteria on other agencies and states, as well as EPA, must be recognized and considered when these criteria are developed and implemented.

6.0 APPLICATIONS OF SEDIMENT QUALITY CRITERIA

Sediment quality criteria will be applicable in many different ways to the regulatory programs described in Section 5.0. In this section, application of the criteria to these programs and specific regulatory concerns within these programs are discussed.

6.1 GENERAL CONSIDERATIONS

The various offices and programs concerned with contaminated sediment have different regulatory mandates and thus, have different needs and areas for potential application of sediment quality criteria. Because each regulatory need is different, sediment quality criteria developed specifically to meet the needs of one office or program may have to be implemented in different ways to meet the needs of another office or program. Therefore, when the criteria are promulgated, several of the survey respondents requested that guidance documents be prepared that describe appropriate applications of the criteria and any modifications in the assessment procedures that may be required to meet the various regulatory mandates. This guidance document will indicate the degree of environmental protection associated with the criteria values, the confidence to be placed in these criteria values, and the specific effects covered by the criteria. In addition, the limits beyond which sediment criteria would not be technically valid should be addressed in the guidance document. These limitations might include the types of compounds, and characteristics of the environment of interest. For example, sediment quality criteria would not be applicable to evaluating the impact of upland disposal of dredged material because of changes in the geochemical conditions of the dredged sediments that would alter the availability of the contaminants. Several respondents questioned whether the criteria will be applicable to highly contaminated areas or to areas where high

concentrations occur naturally. The information contained in these guidance documents will minimize the potential for misapplication of the criteria.

The most likely mode of application of numerical sediment quality criteria is as a key step in a tiered or stepwise evaluation approach and this was confirmed by the survey respondents. In such an application, sediments in which contaminants exceed the sediment quality criteria would be considered to result in adverse environmental impact. Further testing would not be required to label the sediments as "impacted." Any further testing in other tiers of the evaluation approach would most likely be directed toward the need for and applicability of remediation technologies. Contaminants in a sediment at concentrations less than the sediment criteria would not be of concern; however, the sediments could not be considered "safe" because they may contain other contaminants above safe levels but for which no criteria exist. Additional testing in other tiers of the evaluation approach, such as bioassays, could be required to determine if the sediments are "safe" or if other contaminants are present at concentrations that would result in impacts. Contaminant concentrations near the criteria values (i.e., in the "grey area") would also indicate the need for more detailed testing to determine if impacts are indeed evidenced in this sediment. Such detailed testing may include incorporation of site specific information into the evaluation process. Several of the survey respondents emphasized the need to incorporate site-specific information into the criteria and evaluation process when appropriate. As more sediment criteria values become available and experience with these values in the regulatory programs increases, the need for additional testing and the types of additional testing could be significantly modified.

The specific applications described in the following section are directed toward the tier where sediment quality criteria would be used and makes no judgment on the need for or form of the testing in other tiers.

6.2 EXAMPLE OF SPECIFIC APPLICATIONS

Potential applications of sediment criteria can be found in a number of laws. The specific applications under these laws differ, but fall into several distinct categories. The primary categories are summarized in Table 2, which is intended to be illustrative rather than exhaustive. The utility and limitations of sediment criteria would be very similar within each category of application, regardless of the law involved. That is, sediment criteria would be used for site designation in much the same way under any law involving site designation.

6.2.1 Disposal Site Designation

Dumpsites. Sediment criteria could be useful for designating dumpsites under several laws (Table 2). For example, in dumpsite designation under Section 102 of the Ocean Dumping Act, sediment transport patterns predicted for the site by field studies or model calculations should be evaluated to determine their implications for environmental impact. This evaluation could be accomplished by combining transport predictions with sediment contamination data and comparing the resulting profiles with sediment criteria. The sediment criteria would help in evaluating the potential impact to the surrounding area resulting from the transport of sediment-associated contaminants from the site. Sediment criteria could also assist in evaluating the potential impact of contaminants transported from the site in dissolved or microparticulate form and deposited in sediments

away from the disposal site. Such information is important in evaluating the acceptability of candidate dumpsites under a number of laws (Table 2).

An advantage of sediment criteria is that they would add objectivity and consistency to the evaluation of the potential impact of sediment-associated contaminants. They would also assist in distinguishing potential problem sites from those for which there is little cause for concern. However, to be most useful sediment criteria would have to be available for all the major contaminants of concern, and would have to have undergone sufficient scientific and public review to ensure that they are acceptable to the regulating and regulated communities.

Discharge Sites. The application of sediment criteria to the siting of outfalls or discharges (Table 2) would be similar to the application of criteria in the dumpsite designation process. For example, in outfall siting under Section 301 of the Clean Water Act, models or field data could be used to predict the accumulation of dissolved and particulate-bound contaminants in the sediment. Sediment criteria could then be used to help determine whether those accumulations would constitute an unacceptable adverse impact. Discharge siting under several other laws (Table 2) could apply sediment criteria in a similar way. Advantages and limitations of sediment criteria for discharge siting would be similar to those mentioned previously in relation to dumpsite designation.

6.2.2 Permit Evaluation for Dumping and Discharges

Once a disposal or discharge site is designated, sediment criteria could be used in the permitting process. For example, in evaluating a discharge permit under Section 402 of the Clean Water Act, sediment criteria could be used to help evaluate the potential impact of contaminants that would be expected to

TABLE 2. SUMMARY OF POTENTIAL APPLICATIONS OF SEDIMENT CRITERIA IN IMPLEMENTING KEY SECTIONS OF SOME MAJOR ENVIRONMENTAL LAWS.

	Dumpsite Designation	Discharge Siting	Permit Decisions	Dumpsite Monitoring	Discharge Monitoring	Clean Area Identification	Clean-Up Area Selection	Clean-Up Goal Setting	Site Restoration	EIS Preparation
Clean Water Act (1977)										
Section 104								X	X	
Section 301		X	X		X	X	X			
Section 303, 304		X	X		X		X	X		
Section 311						X	X			
Section 402			X	X						
Section 404	X		X	X						X
1987 Clean Water Act Amendments										
Section 118							X	X	X	
Section 404						X				
Section 405			X	X	X					
Section 509		X		X	X					
Ocean Dumping Act										
Section 102	X			X						X
Section 103			X							
Section 301							X			
Resource Conservation and Recovery Act (RCRA)										
Section 1006	X					X				X
Section 1008	X							X		
Section 2004								X		
Section 3004G			X							
Section 3005			X							
Section 3019	X				X	X	X	X		X
Section 7003						X	X			
Section 9003			X	X						X
Superfund Amendment and Reauthorization Act (SARA) and Comprehensive Environmental Response and Liability Act (CERCLA)										
Section 102/103	X					X	X			
Section 105						X	X		X	X
Section 106						X	X		X	
Section 107						X	X			
Section 121	X							X	X	X
Section 205	X									

accumulate in the sediments. These contaminants might be dissolved or associated with micro-particulates in the discharge, and could accumulate in sediments at some distance from the site, or contaminants might occur in the discharged material in solid forms that would settle rapidly to the bottom near the discharge. In either case, sediment criteria could be used in permit evaluations under several laws (Table 2) to help evaluate the potential impact of such contaminants.

Sediment criteria would help in permit evaluation by increasing the objectivity and consistency of the evaluation process. Many survey respondents stated that for the criteria to be useful in permit evaluations, sediment criteria for a wide range of chemicals are needed. Many respondents also thought that use of sediment criteria in permit evaluations, even for screening purposes, would require extensive review of the process used to derive the sediment criteria, and of the resulting criteria values by the scientific community and public.

6.2.3 Disposal Site Monitoring

Disposal site monitoring implies that some action will be taken if the data exceed some level indicating a problem is imminent. Several laws include sections related to monitoring disposal sites and dumpsites (Table 2). Sediment criteria could be the basis for determining whether contaminants were accumulating in sediment to the extent that a potential effects threshold was being approached or had been exceeded. For example, in monitoring a discharge under Section 301 of the Clean Water Act, contaminants would be analyzed in the sediments around the discharge. The concentrations could be compared to sediment criteria to help determine the likelihood of impact.

Sediment criteria would be particularly valuable in site monitoring applications, where sediment contaminant concentrations might gradually approach the criteria over time. Comparison to sediment criteria could be a reliable method for providing early warning of potential problems. Such an early warning would provide an opportunity to take corrective action before adverse impacts occurred. Sediment criteria would have to be available for a large number of chemicals to be most useful in site monitoring.

6.2.4 Site Cleanup and Restoration

Because many contaminants sorb to sediments, sediment criteria could be helpful in evaluating the potential environmental risk posed by in-place pollutants. For example, under Section 303 of the Clean Water Act, sediment criteria could be used to help determine whether an area might benefit from cleanup activities. Under this and other laws (Table 2) sediment criteria could be used to help (1) determine the need for cleanup, (2) set a goal for cleanup, thereby helping to determine the size of the area to be addressed and, thus, the cost of the cleanup effort, and (3) assess the degree of benefit to be realized by cleaning up an area to meet the criteria.

Evaluation of in-place pollutants in aquatic sediments could be one of the most appropriate and immediate applications of sediment criteria. The administrative ease of having established numbers for comparison could, however, encourage over-reliance on the criteria. Because identification of candidate areas for cleanup is likely to be viewed as a less precise process than issuing or denying a permit, there would be less incentive to adhere rigidly to a fixed number. The utility of sediment criteria in evaluating candidate areas for cleanup would increase if criteria were available for a large number of chemicals.

6.2.5 Environmental Impact Statements (EISs)

Sediment criteria could be helpful in evaluating alternatives in the preparation of EISs (Table 2) under the National Environmental Policy Act. In this context, sediment criteria could provide one part of the quantitative basis for comparing the environmental benefits or consequences of various alternatives, including the no-action alternative, to the proposed action. The use of sediment criteria in this context would require field or model data to predict the accumulation of contaminants in sediments as a result of the proposed action and each of the alternatives. Sediment criteria could then be used to help evaluate the potential for unacceptable adverse impacts associated with each of the alternatives.

7.0 RECOMMENDATIONS

- **Both the regulatory and regulated communities need to continue to have access to all information and documentation developed in support of this effort.** As progress is made on sediment criteria development, the dissemination of information becomes more critical to minimize unnecessary concerns and misdirections. Readily available information on the status, progress, and direction of sediment criteria development is the key to ensuring unnecessary uneasiness or concerns are kept to a minimum. It has been the practice in the past to ensure that any person with an interest in sediment criteria development will be able to obtain copies of all documents and work plans generated in support of this effort. This practice should continue and become more pro-active to make people aware of the existence of key documents.

- **The scientific and administrative review underway and planned for the sediment criteria now being developed should be widely publicized.** All those concerned with sediment criteria development should be made aware of the scientific oversight of the developmental work by the Sediment Criteria Technical Steering Committee, past and future presentations of work at national scientific meetings such as the Society for Environmental Toxicology and Chemistry (SETAC), and the planned review of the developmental process and the criteria by the EPA Science Advisory Board (SAB).

- **A technical workshop to allow the scientific community to critique the sediment criteria development process should be scheduled before the process is finalized.** This should be a much larger and more diverse group than the Technical Steering Committee. The group should be provided with the physical/chemical model for sediment-contaminant-water interactions, and the protocols for chemical and biological tests, to be used in developing sediment criteria. The workshop should be followed by a Technical Steering Committee meeting to review and revise the criteria development process as appropriate in consideration of the results of the workshop.

- **Sediment criteria should be developed for as many chemicals as possible.** Sediment criteria will be needed for as many of the metals and organic compounds commonly of concern in sediments as possible. Ongoing research should provide a method for developing sediment criteria for metals. Coordination between the water quality criteria and advisory program and sediment criteria program to increase the number of nonpolar organic compounds for which chronic or advisory water quality criteria are being developed would result in a one-for-one increase in

the number of sediment criteria available. In addition, the use of toxicological end points other than chronic water quality criteria should be pursued.

8.0 SUMMARY

- **The greatest utility of sediment criteria in the near term is likely to be in a variety of applications to identify existing and potential problem areas.** The first sediment criteria that are developed may most appropriately be applied to identify and confirm the potential impact of highly contaminated sediments. With contaminated sediments near or less than the criteria values, the criteria may be used as one tier in a tiered approach to sediment quality assessment.

- **Implementation of many laws and regulations can be improved or made easier with sediment criteria.** These laws and regulations are mainly concerned with siting, permitting, and monitoring of discharges and dump sites; identifying and cleaning contaminated areas; and preparing environmental impact statements.

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APPENDIX A

DISCUSSION OF A SURVEY OF NEEDS AND USES FOR SEDIMENT CRITERIA

APPENDIX A

DISCUSSION OF A SURVEY OF NEEDS AND USES FOR SEDIMENT CRITERIA

A.1.0 INTRODUCTION

To supplement the technical expertise and regulatory knowledge of the sediment criteria development team and review group, it was desirable to contact the regulatory and regulated communities to confirm the characteristics and potential uses of sediment criteria for a variety of applications. Therefore, discussions were held with key personnel in EPA offices and programs as well others that have potential uses for sediment criteria. This appendix reports the results of these discussions.

A.2.0 METHODS

A.2.1 IDENTIFICATION OF KEY PERSONNEL

The original list of interview candidates was compiled by Drs. Richard Peddicord, James Fava, Christina Cowan, and H. Suzanne Bolton. An attempt was made to contact representative EPA offices in each coastal or Great Lakes region that has expressed an interest in sediment criteria. Additional contacts were solicited at the conclusion of each interview. Ultimately, the list of interview candidates increased to over 100, reflecting the wide interest which exists in sediment criteria.

A.2.2 THE INTERVIEW PROCESS

A questionnaire was designed for use during telephone discussions which directed participants through a three-tiered examination of their need for sediment criteria, the characteristics which would make the criteria suitable for their applications, and the specific chemicals for which sediment criteria are needed. The questionnaire was carefully planned to minimize the possibility of influencing the responses by the phrasing or context of the questions. The questionnaire (Table A-1) was approved by the Work Assignment Leader and the program office prior to the interview process. The interview format began with a descriptive introduction of the purpose of the survey, explaining that Battelle was conducting the study for EPA Criteria and Standards Division. The stated purpose of the interview was to assess the need, the potential applications, and the desired scientific characteristics of sediment criteria. The interview was conducted in a conversational tone using follow-up questions to clearly identify the candidate's position on each topic. Because responses were not biased by limits imposed by a particular question, an accurate characterization could be made in the final evaluation of the survey results.

A.3.0 RESULTS AND DISCUSSION

A total of 29 interviews were conducted between March 4 and May 8, 1987. The scope of contacts included eight EPA Regional Offices, three EPA Environmental Research Laboratories, five EPA Headquarters offices, two National Oceanic and Atmospheric Administration (NOAA) offices, five Army Corps of Engineers offices, three state regulatory offices, two members of the academic community, and a public utility (Figure A-1). The discussion that follows is based on the results of these

TABLE A-1. QUESTIONNAIRE USED DURING TELEPHONE CONVERSATIONS CONCERNING SEDIMENT CRITERIA DEVELOPMENT AND USE.

Date:_____ **Name:** _____ **Organization:** _____ **Phone:** _____

DO YOU HAVE A NEED FOR SEDIMENT QUALITY CRITERIA?

Is your office concerned (involved) with environmental effects of contaminated sediment? ____ Soil? ___

In your opinion, what is the regulatory mandate of your office for sediment protection? Under what existing laws or regulations would you use sediment criteria?
[ ] Clean Water Act [ ] Ocean Dumping [ ] NEPA [ ] EIS Other: _____

In your opinion, are new, enabling regulations needed in order for your office to regulate sediment contamination using sediment criteria (SC)?

What approaches are you now using to determine whether or not sediment may be considered a problem (contaminated)?

In your opinion, how would the development of SC improve the way your office presently deals with contaminated sediments? (Compared to whatever guidelines you working with now?)

Would you envision SC as possibly becoming the basis of state regulatory requirements?

WHAT INFORMATION DO YOU NEED TO REGULATE POTENTIAL ENVIRONMENTAL IMPACTS OF CONTAMINATED SEDIMENTS?

Two conceptual approaches have been identified for using SC. One approach would present a single value or a single value with uncertainty to be used as a pass-fail regulation, the second approach would present the SC as the first-cut in sequence of tiered steps. Which type of approach would be most useful to you in regulating sediments: Pass-fail ___ Sequence of tiered steps ____

If pass-fail, which would probably be most useful to your office:
A single value _____ or a single value with uncertainty _____ ? Discussion.

If a sequence of tiered steps, which would be most useful to your office?

A technique such as bioassay which could be used as a first-cut flag or as base for litigation? ____
or a sequence of tiered steps similar to that presently used in developing water quality criteria? Discussion.

What level of scientific strength do you feel you need for SC compared, for instance, with water quality criteria?

In your opinion, does the derivation procedure need to go through formal rule-making like water quality criteria?

WHAT ARE THE MAJOR CHEMICALS OF CONCERN IN SEDIMENTS?

For what classes of chemicals would SC be useful to you?

[ ] PCBs [ ] Dioxin [ ] Metals: _____ [ ] Chlorinated Pesticides _____
Other Specific Chemicals of Concern: _____

Other Comments: _____

Can you recommend other people who you think I should contact about this subject:

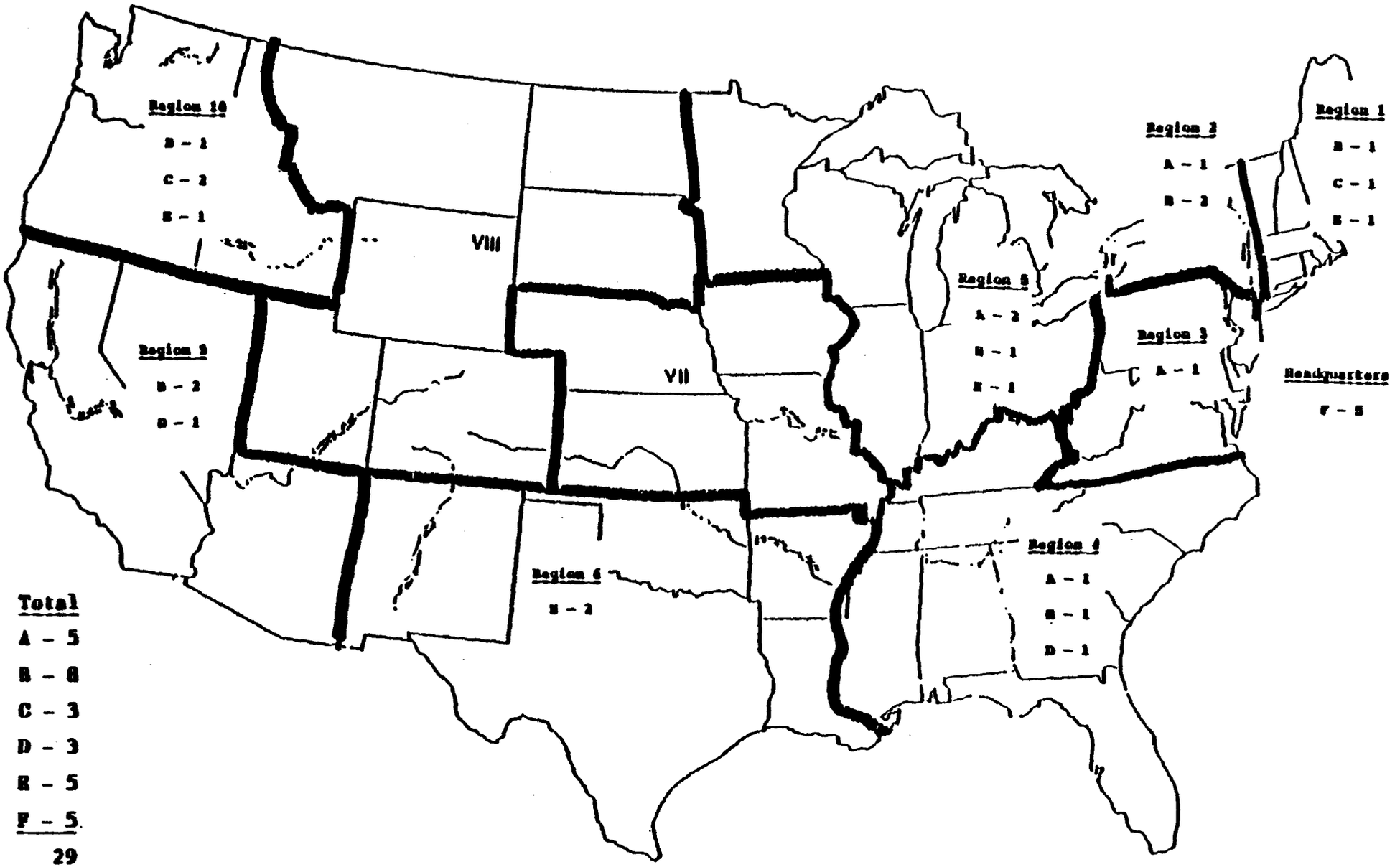

FIGURE A-1. NUMBER AND AFFILIATION[1] OF INDIVIDUALS CONTACTED IN A SURVEY ON SEDIMENT CRITERIA DEVELOPMENT AND USE.

[1]A = Army Corps of Engineers, B = EPA Regional Offices, C = EPA Environmental Research Laboratories, D = State Agencies, E = NOAA, Academic Community, etc., F = EPA Headquarters Offices.

interviews and is intended to be illustrative rather than a quantitative sampling of opinions. Responses are those of the individual interviewee, and do not represent any consensus of views in the respondents' organization or area. The results of the survey, summarized in Table A-2, are discussed in the following section.

A.3.1 MANDATE FOR REGULATION OF SEDIMENT CONTAMINATION

Of the 29 individuals contacted, 97% were concerned with the environmental effects of contaminated sediments. The Ocean Dumping Act and the Clean Water Act are the primary regulatory mandates cited by those involved with sediment contamination, representing 41 and 31%, respectively, of those interviewed. Eighteen percent of those surveyed were involved with the registration of chemicals, including pesticides, herbicides, and new formulations. Eighteen percent were involved in Superfund or Resource Conservation and Recovery Act (RCRA) cleanup issues, and 17% evaluated sediments under National Environmental Policy Act (NEPA) regulations.

A.3.2 PRESENT APPROACHES USED IN SEDIMENT CONTAMINATION REGULATION

In the absence of centralized guidelines, a variety of approaches have been adopted. In many cases, no single method has been adopted by similar offices or within regions. The approach taken seems to be driven, at least in part, by the perceived magnitude of the problems and the backlog of sites awaiting evaluation.

The two general approaches used to assess contaminated sediments are case-by-case evaluations (59%) and mandatory bioassays (38%). Where the case-by-case approach is used, historical data, bulk chemical analyses, and bioassays are usually part of a sequence of tiered decision-making steps. Results of bioassays are used

TABLE A-2. SUMMARY OF A TELEPHONE SURVEY CONDUCTED BETWEEN MARCH 4 AND MAY 8, 1987 WITH INDIVIDUALS SELECTED FOR THEIR INVOLVEMENT WITH SEDIMENT CRITERIA DEVELOPMENT AND USE.

	Respondent Categories[1]						
	A	B	C	D	E	F	Total
Number of Respondents:	5	8	3	3	5	5	29
	Percent of Respondents						
Is your office concerned with environmental effects of contaminated sediments?							
Yes	100	100	100	100	100	80	97
No	-	-	-	-	-	-	-
Not Yet	-	-	-	-	-	20	3
In your opinion, what is (are) the regulatory mandate(s) of your office for sediment protection? (More than one choice possible).							
Ocean Dumping	60	75	33	67	-	20	41
Clean Water	60	25	33	67	20	20	31
FIFRA, TSCA	20	-	66	-	-	60	18
RCRA, Superfund	20	12	33	33	20	-	18
NEPA	20	37	-	33	-	-	17
SRPA	-	12	-	-	-	-	4
N/A	-	-	33	-	80	-	7
What approaches are you now using to determine sediment contamination?							
Case by Case Tiered Approach	40	50	-	100	100	60	59
Manditory Bioassays	60	50	100	-	-	20	38
N/A	-	-	-	-	-	3	3
How would the development of SC improve the way your office presently regulates contaminated sediments? (More than one choice).							
Additional Weight in Decision-making	40	25	33	67	60	60	45
Provide Cutoff Number vs Best professional Judgement	40	38	-	-	40	40	34
Eliminate Manditory Bioassays	-	12	33	-	-	-	10
No Effect (Would not use)	20	25	33	33	-	-	17
Would a sequence of tiered steps or a pass-fail approach be most useful to you in regulating the potential environmental impact of contaminated sediments?							
Tiered Steps	80	62	100	67	100	60	76
Pass - fail	-	12	-	-	-	-	3
Combination of Tiered Steps & Pass-Fail	-	12	-	33	-	20	10
Neither	20	12	-	-	-	20	10

[1] A = Corps of Engineers B = EPA Regional Offices C = EPA Environmental Research Labortories, D = State Regulators, E = Miscellaneous, F = EPA Headquarters Offices.

TABLE A-2. (Continued).

	Respondent Categories[1]						
	A	B	C	D	E	F	Total
Number of Respondents	5	8	3	3	5	5	29
	Percent of Respondents						
How would you use SC in decision-making?							
First-cut Screening	20	38	33	67	40	-	31
Added Weight	40	50	67	33	60	20	45
TSCA Approach (cut-off effects criteria)	-	-	-	-	-	60	10
None of Above	-	-	-	-	-	20	4
Won't Use	40	12	-	-	-	-	10
What level scientific strength do sediment criteria need to be useful and enforceable for your office? (More than one choice).							
Very Strong	60	62	-	33	100	80	62
Legally Defensible	-	25	-	-	20	20	14
More Research Needed	60	25	67	67	20	-	34
Advisory or Guidance	20	50	-	33	40	20	31
Peer Review	20	25	33	67	40	40	34
Need Specific Chemicals	-	-	67	-	20	-	10
Are new, enabling regulations needed in order for your office to regulate sediment contamination using sediment quality criteria?							
Yes	20	38	33	-	40	20	24
No	60	50	33	67	-	60	48
Maybe	-	12	33	-	-	20	7
N/A	-	-	-	-	60	-	10
Irrelevant	20	-	-	33	-	-	7
In your opinion, does the derivation procedure need to go through formal rule-making like water criteria?							
Yes	-	25	33	-	60	80	34
No	20	12	33	33	20	20	21
Hope Not	20	25	-	33	-	-	14
Doesn't Care	20	-	-	-	-	-	4
Not Yet	20	25	-	33	20	-	17
N/A	20	12	33	-	-	-	10
Would you envision a Sediment Criteria becoming the basis of state regulatory requirements?							
Yes	20	50	67	33	60	40	45
Maybe	20	25	33	33	40	20	28
Hope Not	20	12	-	33	-	-	10
No	-	12	-	-	-	-	3
N/A	40	-	-	-	-	40	14

[1]See previous page.

either as a basis for requiring further work (chemical analyses or bioaccumulation tests) or are, themselves, the endpoint used for decision-making. In cases where bioassays are mandatory, these other parameters may or may not be examined as part of the decision-making process.

A.3.3 APPLICATIONS AND ADVANTAGES OF SEDIMENT CRITERIA

A.3.3.1 Immediate Applications

In general, many respondents (76%) envisioned using sediment criteria as part of the tiered decision process they now use. One respondent suggested: "Sediment chemistry values would be compared to the sediment criteria. If sediment concentrations were well below the criteria value, no bioassays would be required and a permit would be issued. If sediment concentrations were well above the sediment criteria values, bioassays and more specific analytical chemistry would be mandatory. If sediment concentrations were close to the sediment criteria values, the amount and kind of future testing and analysis would be determined by evaluation of the available data based on best professional judgment."

A.3.3.2 Long-Range Applications

Most respondents are eager for some type of sediment criteria and readily suggested potential applications for sediment criteria. In general, applications fall into three categories: prediction and planning, baseline establishment, and expediting decision making. In all these applications the desire for numbers based on scientifically rigorous testing (i.e., lab and field verification of the values) was universal. The regulation of municipal and industrial discharges involves not only the types of decisions required in dumping permits, but also long-range planning, since discharges represent what is essentially chronic exposure. Sediment criteria would be useful in the planning,

prediction, and decision-making required in discharge permits.

A.3.3.2.1 Prediction and Planning

Dumping. There is a widespread desire for the ability to predict both the potential short-term impact of the disposal process itself and the long-term effects of dumping on the dumpsite before regulating decisions are finalized. Sediment criteria could help evaluate potential effects of contaminants accumulating in sediments from various dumping activities.

Discharges. Sediment criteria could be used to help evaluate trends in transport of contaminants from point and non-point sources. They could be incorporated into software inventories that would track present discharge levels from point sources, and predict whether contaminant accumulation rates from all sources would require action. Used in conjunction with effluent testing, estimates of storm water run-off and other non-point source contributions, and hydrologic models for specific water bodies, sediment criteria could help evaluate the environmental importance of dispersal, settling and accumulation of contaminated sediments. Sediment criteria could be incorporated into environmental fate and effects models to help assess the potential for unacceptable adverse impact. Such predictive models would require both lab and field testing before they could be used with assurance.

Planning. Many states recognize the need to plan the use of waterways and to anticipate the cumulative effects of many point and non-point sources of pollution. Some states are in the process of developing master plans for the use and protection of lakes, rivers, harbors and estuaries. Sediment criteria could be

incorporated into long-term planning as clean-up targets, or as average maximum allowable levels.

A.3.3.2.2 Baseline Establishment

The need for baseline data is a common theme among respondents. Most areas have no baseline or historical data which can be used to help determine what is clean and what is contaminated. Sediment criteria could help provide a target number for cleanup, a comparative baseline for dredging and dumping decisions, and a benchmark number for examination of the cumulative effects of outfalls. Sediment criteria could be used in sediment surveys to create contamination maps, noting trends of contamination spread and patchiness, which could be used as indicators of the overall condition of water bodies.

A.3.3.2.3 Decision-making

Sediment criteria would permit respondents to streamline the permitting process. The crisis that many face is typified by the respondent who said "I'm so backlogged with NPDES permits that I don't even have time to think about sediments." While this is an extreme case, the backlog of permits and decision making is universal. This backload is created not only by the volume of applicants but by the approach used by most offices in making decisions on a case-by-case basis. In many cases the same information is recreated with each application.

Dumping. Sediment criteria based on bioavailability could be used to help determine whether additional testing were needed and if so, what types of testing would be appropriate for a specific site. One survey respondent thought "Sediment criteria might do away with need for bioassays if the bulk chemistry analysis could

be judged against a defensible sediment criteria number...allowing evaluation of dumping impact without requiring bioassays."

Discharges. In the need for decision-making tools, most respondents would use sediment criteria primarily as part of a sequence of tiered steps. Sediment criteria would probably be incorporated into state regulations as a target for sediment loading or contamination, and could be used as part of the basis for closing areas for shellfishing. In some cases, sediment criteria would probably be used like the water quality criteria, providing a fixed number for enforcement. Many respondents feared such an over-application of sediment criteria, and this would be beyond the intent of the criteria.

A.3.4 DESIRABLE SCIENTIFIC CHARACTERISTICS FOR SEDIMENT CRITERIA

Regardless of the specific application, the survey supports the contention that the decision to use sediment criteria will be based primarily on the confidence respondents have in the derivation process. The essential characteristic that will ensure this confidence can be summarized in one word: data. The recurring theme of "Good data...enough baseline data... real data...hard data..." makes this the critical issue for acceptance and use of sediment criteria.

Sediment criteria will be used either as stand-alone numbers for regulatory purposes, or in conjunction with an application factor, or as part of already existing decision-making procedures. Those who are potentially involved in litigation activities (62% of respondents), commonly expressed the view that they cannot use sediment criteria as the basis for permits or litigation if the numbers are not "scientifically defensible... rigorous...with strong teeth... hard...real..." Almost 34% of

respondents desired to see sediment criteria developed as the water quality criteria were developed: with multispecies, round robin testing, peer review, public scrutiny, and finally, Federal Register publication. Some feel that both field and laboratory testing are necessary to support the sediment criteria. Many survey respondents recognized that this process could take 5 to 10 years, and suggested that sediment criteria advisories or guidance documents be published in the interim. On the other hand, sediment criteria will require much less testing and validation for the 31% of respondents who said they will use the values only as guidance. In these cases, the values must only be supported by "a good database that supports the criteria derivation process."

In either case, most respondents believed that sediment criteria should consider the interrelationships between sediment contamination, bioaccumulation, and toxicity.

A.3.5 LEGISLATION

A.3.5.1 Need For Formal Rulemaking

The mandate to regulate the contamination of sediments and to remediate sediment contamination is contained explicitly or implicitly within the framework of existing legislation. In some cases, the decision-making criteria are contained in the legislation itself. In order for sediment criteria to be implemented in these cases, new legislation may be required. Where the decision-making process is loosely defined and left to the regulating office, it is unlikely that new legislation will be required.

Under its present mandate, the U.S. Army Corps of Engineers would not use sediment criteria, alone, as specific cut-off numbers. Because their mandate requires that decisions include other considerations in addition to potential environmental impact, sediment criteria would not, in themselves, drive the decision. Because the Corps has no requirement to use sediment criteria values, many Corps respondents (60%) feel that there is no need for new regulations. In addition, sediment criteria could be used as guidance within the context of present regulations.

Many respondents either were unsure or disagreed on whether new legislation would be required in order for them to use sediment criteria: 48% felt that no new regulations would be needed, but 31% thought that new legislation was possibly or definitely required. In general, acceptance depended upon the specific application for which sediment criteria will be used. If used as a technical aid, sediment criteria would not require new enabling legislation because published technical documents become articles of practice or support documentation for many regulating offices. In fact, as one respondent said: "Sediment criteria presented in guidance documents will be of more use to a wider audience: formal structure loses application." On the other hand, 34% felt that the sediment criteria should go through the same formal rulemaking and review as did the water quality criteria: 21% felt that formal rulemaking is not necessary and another 17% felt that it is not desirable at this time. The rulemaking process would provide the exposure to and comment from the scientific community needed if sediment criteria are to be used in litigation. One respondent stated, "If sediment criteria do not go through the same rigor as the water quality criteria they will be second-class citizens."

Some respondents thought that the Clean Water Act, the Ocean Dumping Act, and Superfund may have to be modified in order to

use sediment criteria for some applications. Some feel that the mandate to use sediment criteria may exist implicitly in water quality criteria and that if sediment criteria are as environmentally protective as water quality criteria, there will be no need for additional legislation. In freshwater applications, some felt "it will be difficult to link discharges to elevated contamination levels down-stream" in remediation efforts based on sediment criteria without new legislation.

A.3.5.2 Legislation at the State Level

Based on the results of this study, 45% felt that sediment criteria would become the basis of state regulations and another 28% saw a potential for this use. While there is a great need for numerical guidance, 10% of the respondents at either Federal or Regional offices expressed concern that numerical values published by EPA would probably be written into state legislation without full understanding of the intent and proper application of the numbers. Therefore, legally and technically defensible sediment criteria values are essential and would require both public scrutiny and peer review through publication in the refereed scientific literature.

Many states are creating and promulgating sediment criteria for their own use. Both Washington and Wisconsin are developing state-wide sediment criteria at present. Federal sediment criteria and the methodology developed to derive these criteria should augment the State efforts and provide a basis for meeting multistate needs in interstate waterways.

A.3.6 CHEMICALS OF WIDEST CONCERN

The specific chemicals for which sediment criteria are needed are determined by the regulations and permits implementing the

environmental laws. Some permits require testing of the full suite of priority pollutants. Others require bulk analysis of specific classes of chemicals or target individual chemicals. At the state level, additional specific chemical analyses may be required.

The six major classes of chemicals for which sediment criteria are most needed according to the respondents are the heavy metals (72%), followed by PCBs (59%), PAHs (41%), chlorinated pesticides (34%), dioxins (24%), and "persistent compounds" (17%) (Table A-3).

A.3.7 EXAMINATION OF MAJOR CONCERNS

Only 7% of those interviewed expressed no concern over the present sediment criteria development strategy as they understood it. All others voiced a variety of opinions about the need to modify the development process. Over 50% expressed the opinion that the present sediment criteria development is not sufficiently effects-based. They felt that the criteria should include risk assessment for a defined level of protection and should include an assessment of the effects of bioaccumulation. Eighty percent expressed some concern for the chemical methodology, questioning the validity of extrapolating sediment criteria derived from single-chemical testing to complex mixtures and a variety of geochemical parameters, and the inadequacy of the present state of the science to sample and measure contaminant concentrations consistently. Forty-one percent expressed concern about the potential for over- or under-regulating sediment contamination, the misuse of sediment criteria values by the states, or overly rapid development of sediment criteria. These misunderstandings can be addressed if the long-range plans for sediment criteria development and implementation are described.

TABLE A-3. CHEMICALS NAMED BY SURVEY RESPONDENTS AS ONES FOR WHICH SEDIMENT CRITERIA WOULD BE USEFUL. RESULTS ARE REPORTED AS THE PERCENT OF RESPONDENTS IN EACH CATEGORY AND AS THE PERCENT OF THE TOTAL NUMBER INTERVIEWED.

Chemical Type	Respondent Category						Percent of Total Respondents
	A	B	C	D	E	F	
Heavy metals	100	88	67	67	60	40	72
PCBs	100	88	33	33	40	20	59
PAH	60	38	33	100	40	-	41
Chlorinated Pesticides	40	25	-	33	40	60	34
Dioxin	80	25	-	-	-	20	24
Persistent compounds	20	-	33	33	20	20	17
Carcinogens	-	-	67	33	-	-	10
Chlorinated hydrocarbons	20	-	-	67	-	-	10
Total organics	-	25	-	-	20	-	10
Priority Pollutants	-	25	-	33	-	-	10
Oil & Grease	-	25	-	-	-	-	7
Furans	20	-	33	-	-	-	7
DDT	20	12	-	-	-	-	7
Neutral hydrophobics	-	-	-	-	-	20	4
Bioaccumulatable cmpds.	-	-	-	33	-	-	4
Charged Organics	-	-	-	-	-	20	4
Total Phosphorus	-	12	-	-	-	-	4
Volatile Organics	-	12	-	-	-	-	4
Organic Nitrogen, Carbon	-	12	-	-	-	-	4
Organophosphate	-	-	-	-	-	20	4
Incineration Products	-	-	33	-	-	-	4
Nutrients	20	-	-	-	-	-	4
Organic Distillates	20	-	-	-	-	-	4
Total Dissolved Sulfides.	-	12	-	-	-	-	4
Total Organic Carbon	-	12	-	-	-	-	4

Open communication with respondents will be the crucial factor in the recognition and acceptance of sediment criteria. A sampling of respondent thoughts and concerns is presented in Table A-4.

TABLE A-4. REPRESENTATIVE COMMENTS FROM RESPONDENTS TO THE TELEPHONE INTERVIEWS.

"If sediment criteria were based on good data, they could be used as part of the assessment for whether or not testing was necessary." Corps of Engineers

"Walk carefully. Nontechnical people want an easy number. This usually results in overregulating or underregulating." Corps of Engineers

"Once there's a baseline, maybe we won't have to do analysis every time." Corps of Engineers

"I like the partitioning-based idea of sediment criteria for hydrophobic organics combined with field testing." Corps of Engineers

"If sediment criteria are related to bioaccumulation and toxicity they would provide numerical criteria which could be used with bioassays." EPA Region 1

"Sediment criteria should be commensurate with water quality advisories, not criteria." EPA Region 1

"The present analytical methods aren't good enough for a certified document. Sediment criteria should be issued in a guidance document." EPA Region 2

"I basically doubt that a good baseline can be developed." EPA Region 2

"Sediment criteria would legitimize the decision to forego bioassays...sediment criteria might provide a relaxation of the bioassay requirement, which is very costly." EPA Region 4

"Pilot them. Try them in real-life situations." EPA Region 5

"Sediment criteria would be a parameter factored into the assessment of dredging- or construction-generated sediments for disposal; a target for sediment loading or contamination." EPA Region 9

"Strong scientific strength would be nice but right now it's seat-of-the-pants anyway. Sediment criteria would give us a place to start." EPA Region 9

"Sediment criteria would be a number to go by just like water quality criteria to be used for enforcement vs best professional judgement. They must be site specific and compared with a reference site, and must take into account naturally occurring high values." EPA Region 9

"Sediment criteria must have more than a theoretical base. They must incorporate field data and biological fate information, and must be predictive." EPA Region 10